THE

ELECTRICAL REVIEW.

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J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

For 1893,

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RAILWAY ACCIDENTS, 1891.

ELECTRICITY plays so important a part in the control and management of railways, that it is always interesting reading to study the otherwise somewhat dread figures which usually occupy the foremost position in the returns made to the Board of Trade periodically by the officers of that department entrusted with the railway branch. Year by year we have found the "block" extending itself, until a very large portion of the entire railway system has been placed under its regulation and control. We are now approaching, although we have not yet quite reached the date on which (under the powers accorded the Board of Trade by the recent Railway Regulation Act) all lines of railway worked by more than one engine are to be provided with a block system, and the signals are to be otherwise interlocked.

When this condition has been reached our railway system will, in its safety appliances, stand unrivalled throughout the world; but high as its status will then be, we shall still lack the all-important link which is required to bind the electrical to the mechanical "block." As has been more than once pointed out in these columns, the two systems by which the enormous traffic of the country is to all intents and purposes controlled, are worked perfectly independent the one of the other. It is by means of the electrical signals that the signalman is called upon to operate his mechanical signals which tell the engine driver whether he is to go on or not. He sees that the electrical signal is placed to "line blocked," or "train on line," and thereon he places his line, or mechanical signals, at danger. There is nothing beyond his sense of duty to compel him to do so. We are exacting compulsory interlocking for signals and points. May we not go a step further, and interlock the electric with the mechanical signals, and so make that which is so near perfect still more so? Sincerely do we hope that the date is not far distant when this one more security—a security as important as any which has preceded it—will be added to the roll of improvements which have from time to time been effected by our more advanced railways, with so much credit to themselves and so great advantage to the travelling community.

The returns for the past year, only recently published, must be regarded, viewed from the point of loss of life to passengers, as highly satisfactory. 1891 shows but five killed, the lowest number yet reached. The number injured is not quite so gratifying; 875 is 379 over the number injured during the preceding year. Having regard, however, to the fact that any description of injury, if only a scratch or a bruise, comes within the category of injured, too much stress should not be laid upon the number, beyond a hearty desire that it should disappear altogether, which we fear will never be the case. The proportion of killed to the number of passenger journeys is the highest yet reached,

viz., 1 in 169,092,733. The highest previous result was that for 1885, when the number killed was 6, and the proportion of killed to passenger journeys was 1 in 116,202,171.

The number of accidents enquired into reach 68, as against 53 for the previous year. Of these, three come under the head of collisions between engines and trains following one another on the same line of rails; four under that of collisions at junctions; twenty-five from collisions within fixed signals at stations and junctions; three from trains or engines meeting in opposite directions; the rest being classified under heads with which electricity has little to do.

The following remarks, which are appended to the most important cases noted, are of interest. Referring to the collision which occurred in the tunnel between St. John's Wood Road and Marlborough Road Stations on the Metropolitan Railway on June 4th, on which occasion fourteen passengers and four company's servants were injured, it is pointed out that "this mistake would have been prevented had the down starting signal at St. John's Wood Road been electrically locked from Marlborough Road."

In dealing with the collision which occurred on the Caledonian line on April 30th at Dalry Middle Junction, we find the remark :—"The inspecting officer pointed out the necessity for some additional safeguards, by which signals and block instruments can be kept locked at danger when a train has been crossed on to the wrong line, even after the cross-over road points have been restored to their normal position." And in speaking of that which took place at Norwood Fork Junction, on the Brighton line, on December 17th, during a dense fog, on which occasion forty-one passengers and two company's servants were slightly injured :—The mistake on the part of the signalman "might have been rendered harmless had a system of electrical interlocking been in force between Windmill Hill and Norwood Fork Junctions."

Similar suggestions, advocating a strict adherence to block working, not merely as regards straight sections, but also with respect to junctions; interlocking the electrical with the mechanical signals; and, in one instance, the possible propriety of adopting some automatic means for fog signalling occur, as the cases under consideration afford opportunity.

Summarising the circumstances which contributed to the several accidents of the year, we find eight attributable to a "defective system for securing intervals between trains, or want of telegraph communication," or of block system, and 61 to "negligence, want of care, or mistakes of officers or servants." With respect to the latter, the Secretary to the Board comments as follows :—"It is with regret that I have had to refer to a number of accidents attributed to mistakes or neglect of companies' servants. The protection of the public safety, which the block system is designed to secure, depends for its efficiency on the care, attention, and obedience to regulations of several classes of the companies' servants. The maintenance of a high standard of duty has produced, and it is hoped will keep up, that large degree of confidence which has been shown by the public, and in my opinion justly shown, in the servants of the companies concerned in the movements of trains." The comment is both complimentary and condemnatory. There is no institution in which greater confidence is reposed by the public in those who have its manipulation than that of our railways, and there is, as a body, no class of men who are more worthy of it. It is quite impossible to overstate the importance of strict attention to rules and regulations, and to duty, on the part of those concerned, nor do we for one moment believe that this is not fully realised by the men themselves. We believe that, as a rule, an honest pride in having faithfully performed their allotted duty animates them, and, whilst fully recognising the importance of a high state of discipline amongst the staff, we cannot refrain from an expression of regret that the apparent negligence of a very few should in any way be allowed to tarnish the high character so deservedly earned by the general body of railway servants.

The progress made in the establishment of the "block" to the date of the Report is indicated in the following figures :—The mileage of double line open for traffic was then 10,999 miles, of which 10,650 was worked on the absolute block system, and 61 miles "on other telegraph systems." The mileage of single line was 8,229, of which it is stated that 5,599 was worked under the absolute block, 192 under "other telegraph systems," and 2,534 miles either by single engine, train porter system, or train staff system. There, therefore, still remains some 349 miles of double line to be "blocked," whilst some 1,674 single line mileage, quoted as worked under the train staff system, would also appear to require to be yet brought within the same category. It will be observed that the mileage rendered as that open for traffic does not quite accord with that given under the different systems adopted for its protection. This, no doubt, is to be accounted for by discrepancies in some of the returns rendered, but which will not very materially affect the result.

DIRECTION OF ELECTRIC MOVEMENT.

IN a recent issue of our contemporary, the *Electrical Engineer* of New York, there is a discussion of the very difficult question of the direction of movement in the electric current or discharge. The writer, Mr. Philip Atkinson, convinces himself that "the theory of the dual nature of electricity, and of the simultaneous movement of the two kinds in opposite directions in the same conductor, must be rejected as unsustained, inconsistent with the theory of difference of potential, and contrary to the observed movement of kindred forms of physical energy, as light and heat."

If Mr. Atkinson has established this proposition, he will have settled what is still a vexed question among the savants on this side of the Atlantic. The evidence offered by him in support of his thesis has, we regret to say, disappointed us; and his arguments appear to us to be new, but not true. For instance, it does not follow that "the movement of the electric energy is from the positive pole to the negative," because the brush discharge from the positive pole of an influence machine is more prominent, radiant, and brilliant than that from the negative pole. Nor does it follow that "the discharge is a transfer of energy from positive to negative," because we find we can get a longer spark from an influence machine by putting the negative pole to earth, than by putting the positive pole to earth. There is nothing in the great difference between Lichtenberg figures,

or contact photographs of the positive and the negative discharges, from which we can deduce, in the present state of our knowledge, any certain conclusion as to the direction of movement in the electric discharge. It is evident that an argument which the plain man would regard as a *non sequitur*, may be regarded by Mr. Atkinson as conclusive.

Though we cannot admit the force of Mr. Atkinson's arguments, we believe his conclusions in the main are correct. Some recent experiments with the electric discharge by Prof. J. J. Thomson (*Proc. Roy. Soc.*, V. 49, p. 84, 1891), show that the luminosity which accompanies the discharge in vacuum tubes moves from the positive to the negative pole, or, more strictly speaking, from the anode to the cathode of the tube, and that it moves at a measurable rate. Wheatstone, in 1835, observed the appearance presented in a rotating mirror of a discharge through a vacuum tube, 6 feet in length; he concluded from his observations that the velocity with which the flash went through the tube could not have been less than 2×10^7 cm. per second. Plücker (*Pogg. Ann.*, V. 107, p. 89, 1859) concluded from the action of a magnet on the discharge that it started from the anode. The experiments of J. J. Thomson fully bear out this conclusion, for he finds that except under exceptional circumstances, the luminosity of the positive column begins close to the anode, and travels away from it.

The discharge was sent by an induction coil through a vacuum tube about 50 feet long. The whole surface of the tube was blackened except two short lengths, one near one end of the tube and the other at the centre of tube. A mirror was mounted on an axis which could be turned at a speed of 400 to 500 revolutions per second, by means of an electromotor, and was fixed in such a position with reference to the vacuum tube, that the images of the luminous exposed parts in the mirror when at rest, appeared to be in line. When the mirror was rotated, the images of a discharge which had been started at the proper moment, were found to be no longer in line, one being displaced laterally relatively to the other. This proved conclusively that the mirror had turned through a measurable angle while the luminosity was passing through the 25 feet of tube which separated the two uncovered sections of the tube. By reversing the direction of the current the displacement was reversed. As stated above, the luminosity invariably started from the anode; the rate of propagation was found to be about half the velocity of light.

These experiments of J. J. Thomson's show that the visible phenomena of the electric discharge have a certain direction of movement, but whether this can be considered to be the direction in which the electricity moves depends on what meaning we ascribe to that much abused term. We have recently had many theories of the electric current presented to us by ambitious physicists. Some have offered us a one-fluid theory, others a two-fluid theory, while a third party, led on by the *ignis fatuus* of a moribund hypothesis, have asserted that the electric current does not flow along the conductor at all, but through the dielectric, and, laterally, into the conductor, where it is dissipated in heat. The theory of the electric current or discharge that now appears to obtain greatest credence is that it is a dissociation phenomenon; or, as it has been put, "chemical decomposition is not to be considered as an accidental attendant on the electric discharge, but as an essential feature of the discharge, without which it could not occur." Until it is understood exactly what is meant by the term electricity, it is idle to talk of the direction of its movement; all we can predicate in the meantime must relate to such of its manifestations as we understand.

THE DANGERS OF THE TROLLEY IN NEW YORK.

BROOKLYN and New York are contiguous, but the likes and dislikes of the two cities are widely different. Brooklyn is progressive, and its authorities have recognised the advantages of a trolley street railway system. Here a line about 12½ miles long has been served by the overhead electric system for some time, and with such success that now 110 new motor cars are on order, to equip a road of 190 miles, which is being laid at the present moment. This is a large undertaking, but it does not create much surprise in America, where the trolley car has leaped into favour in most of the cities. What is astonishing, both to Americans and ourselves, is the strong opposition to a similar service for New York. If we may take the *Electrical Review* of New York seriously, the daily papers are doing all in their power to prevent the introduction of the trolley. They undoubtedly have their reasons, and perhaps cogent ones too; but they also make use of "utterly false statements, convey ideas that are calculated to terrorise the community at large, and make people think that the city is about to be invaded by a deadly machine that will number its victims by the thousand." So the technical journals of New York are up in arms to defend the trolley against all comers, especially cable trams. It seems to us that the best answer to the "cable ring" is the magnificent plant now being installed in Brooklyn. The power station is at the corner of Fifty-Second Street and First Avenue, and will be, when finished, "one of the grandest power stations in the country." The tension chosen is, as usual, between 500 and 600 volts; the car speed is limited by the city ordinances to 10 miles per hour, but the present service does not exceed from six to seven. The wires are strung on poles 28 feet long, set 6 feet into the ground, and placed at intervals of 130 feet. The trolley wires are protected by steel guard wires running parallel to them, about 6 or 8 inches away. No accident has so far been reported in connection with the overhead wiring, and since each section is provided with automatic devices for switching off at the power station, it does not appear likely that any serious disturbance is possible. Mr. M. G. Starrelt, the chief engineer of the power house division, has given the following data relating to the expenditures of the plant:

"Station expenses for week ending August 21st, 1892:—Coal for power, 344,715 pounds; oil for dynamos, 24 gallons; oil for cylinders, 6 gallons; waste, 38½ pounds. Station load: average ampères, 702; average voltage, 526; average number of motor cars, 52; average ampères per car, 13½. Car mileage: motor cars, 36,248; tow cars, 6,128; total mileage, 42,376."

These figures are, it will be noted, from a medium size plant of 52 motor cars, each averaging 100 miles per day. The service is maintained throughout the twenty-four hours, the number of cars being varied to suit the traffic. The coal

consumption is about 8 pounds per car mile; and the energy absorbed per motor car averages 9·4 electrical horse-power, or 2·25 horse-power hours per car mile.

The habits of the people of Brooklyn are chronicled in a rough way by the daily diagrams of the station. After 12 p.m. the output from the station is only about 600 ampères, and this slowly decreases till 2 a.m. From then till 4 a.m. the minimum traffic is found to obtain; and after this it steadily increases till 6 a.m., when the mechanics and labourers begin to go to work. The load goes on increasing till at 7 a.m. there is a rapid rise as the second and largest group of workmen are carried to their respective places of business. After this the output is irregular until noon, when the lowest output for the day service obtains; from then to 3 o'clock there is again a steady rise to about 1,000 to 1,500 ampères, according to the weather and state of the track, this period being the hottest and busiest part of the day. The demand is irregular until about 5 p.m., when the people begin to return home; and the rate of decrease is fairly uniform until midnight. Each day has its peculiar diagram, varying with the weather and the traffic.

Surely, a careful and unprejudiced study of this plant should help to disabuse New Yorkers of their objections to the trolley. We wish the technical press all success in their laudable efforts, and have no doubt that ultimately they will silence the captious criticism of the "cable ring."

Armature Burn Outs.

THIS is a complaint with which we, in this country, are happily not very heavily afflicted, but to judge from a correspondent of the New York *Electrical Engineer*, it is quite common in the "Land of Liberty." The correspondent speaks of frequently burning out, on starting especially, if they are stopped in a "sizzling" condition the night before. Apparently, it is not unusual to run dynamos in the States until the core insulation, &c., is reduced to the state of charcoal. Under such circumstances, the superior ventilation of the Gramme armature may tell as much in its favour as this correspondent seems to believe it does.

Elihu Thomson's Telephone System.

A SOMEWHAT remarkable telephonic system, devised by Professor Elihu Thomson, is described in a recent issue of the *Western Electrician*. In this system (which we may remark is not stated to be in practical operation) the currents for working the whole of the apparatus at an exchange and at the subscribers' offices are generated by an alternating current dynamo placed at the exchange office, giving currents of low frequency. The alternating currents from the dynamo pass through the primary of a transformer, and the secondary circuit of the latter is connected to the primaries of a number of small transformers or induction coils corresponding to the number of lines entering the exchange, all the primaries being joined in parallel. The secondaries of the induction coils are severally in circuit with the subscribers' lines, so that induced currents of low frequency are kept circulating continuously in all the lines, which currents hold the call indicator shutters up. If the exchange wishes to call a subscriber or *vice versâ*, it is only necessary to break the circuit of the particular line, and the currents being cut off from the indicator the shutter of course at once falls. So far there is nothing remarkable in the arrangement, but the point of novelty lies in the fact that these alternating currents in passing through the secondary of the usual induction coil at a subscriber's office, induce currents in the primary wire, and as the latter is in circuit with the microphone in the usual manner, the variations in the latter, when spoken to, vary the strength of this induced current, and cause currents to be induced in the secondary circuit, which currents are superimposed on the constant alternating currents flowing in the same. As the latter currents from their slow frequency do not affect the telephone receivers, the latter are affected in the usual way by the currents induced by the action of the microphone. The whole idea is certainly very ingenious and pretty, but we should like to hear whether it works out successfully in practice.

Medical Electricity.

OUR New York contemporary and namesake announces that it will, in future, devote every week a portion of its space to medical electricity. This department has been put under the charge of Dr. J. Mount Bleyer. We are not, as we have several times stated, among those who hold that medical electricity ought to be excluded from electrical journals, and therefore are of opinion that the step above referred to is in the right direction. Good service may doubtless be rendered to the cause of electro-therapeutics by a series of articles, in which the various physical problems which affect physiological conditions are carefully discussed. Two numbers containing these articles have already reached us, and judging therefrom, we presume they are intended for medical men, and for medical men who are in a very elementary stage of their electrical education. Otherwise the writer would hardly take up the space of an electrical journal with elementary definitions of such words as voltameter, voltage, &c., but would, on the other hand, explain some of the medical terms used, such as diathesic conditions and amphysemitic diseases. In dealing with "Some Physiological observations on Broken Currents or Intermittent Currents," some remarks of ours in a recent article receive prominent notice, but no attempt has been made to discuss one or other of the points we there ventured to indicate as open questions. The question, for instance, as to what is the prime factor in determining the immunity from danger observed by Tesla and others when handling alternating currents of high potential and frequency, is one needing the careful consideration of all interested in electro-physiological problems.

The Substitution of Incandescence Lamps for Dead Resistance in Arc Lights.

Mr. M. C. HEIM has made a number of experiments in order to test the feasibility of putting a batch of incandescence lamps in series with an arc lamp running off a 110-volt circuit. The results of his researches are published in the *Elektrotechnische Zeitschrift*, of July 8th. They seem to show that it is possible and practicable to do this if a small resistance of about ·5 of an ohm be put in series with the circuit at starting and until the carbons have acquired their permanent running temperature. He says that incandescence lamps used in this way are quite serviceable for lighting, since the P.D. at their terminals will not vary more than 1·3 per cent. with a good arc lamp. And also the arc will remain as steady and the feed be as regular as if the excess of voltage were absorbed by a metallic resistance. We believe that this scheme has already been tried and given up owing to the complication involved in the wiring of the 10 or more parallels, and also from the risk of trouble from broken filaments. It does not appear to us that the plan has any serious objection where the group of lamps could be confined to a small area, but such cases are rarely met with; and we expect the saving of power is generally of secondary importance. The use of arc lamps in parallel on low tension circuits is open to objection, and though they are being used in America, it is doubtful whether the installations are very satisfactory. Arc lamps work best in series, and the minimum number should not be less than six or seven lamps. A series-parallel distribution at about 350 volts will work very efficiently; for example, the street lighting in St. Pancras; but this is very different to running two arc lamps in series; or one arc and a batch of incandescence lamps. We do not expect the idea to find favour with English engineers.

THE LUSHAI FIELD TELEGRAPHS, 1889-90.

THE hill tracts south of Assam and between Bengal and Burma have for many years past been productive of trouble to the three local administrations. No positive declaration of annexation had been made, the country was almost entirely unknown, and inhabited by lawless and bloodthirsty hill tribes, who were often at war with each other, and who, as they do even at the present time, occasionally committed raids upon tea estates and villages in British territory. To punish certain of the tribes for these offences was the object of the military expeditions of 1871-72, of 1888-89 and 1889-90. More recently columns have operated again from Assam and Burma. Telegraphs have always been used in these operations, and in the last two expeditions the heliograph very extensively. The latter has been worked by military parties, but the field telegraphs by the civil department. In 1871-72, the line that had been erected was dismantled when the troops withdrew. In the season 1888-89 a permanent line on iron standards was erected from Chittagong, on the coast, to Rangamatti, on the Kornafuli River, some 60 miles up this natural approach to the Lushai Hill tracts. A line on trees was also continued to Demagiri and to Lungsin, about 60 miles further. The difficulties encountered, owing to the dense forest, overhanging creepers, the absence of a practicable road, and the intensely malarious climate, were very great. At the end of the season of 1888-89 Lungsin remained the most advanced police post, beyond the nominal British frontier, and looking eastward, over lofty ranges of mountains, stretching for hundreds of miles towards Burma. It was decided that during the cold season of 1889-90 a fresh expedition should, for political purposes, be undertaken, and that columns from the Chittagon and the Burma sides should march through the Lushai and Chin countries respectively and join at a place called Haka. The telegraph was, if possible, to be carried right through.

The first task was to procure labour. There is none to be had in the Lushai Hills. Indeed, most of the tribes were unfriendly. The country is scantily populated, and the villages of small extent, situated on the tops of mountains, from which the forest has been cleared sufficiently for cultivation. In Chittagong, a large number of coolies for the purpose in view was not readily forthcoming, so recourse was had to the Southal Pergunnas, in Bengal, from which district some 300 men were easily got, and brought by steamers from Calcutta to Chittagong. Their rations, medical attendance, shelter, and organisation into working parties had necessarily to be arranged for, which at first involved a good deal of work on the part of the supervising officers. The separate parties, when work on the line commenced, were under the control of subordinate officers of the Telegraph Department.

The transport of stores called next for attention. For 60 miles from Chittagong, up the Kornafuli river to Rangamatti, small steamers could run. But beyond, for another 40 miles, small country boats, capable of containing a dozen persons, were only available, so that transport here became tedious, and also, owing to the rapids, dangerous. Some stores were entirely lost by boats capsising, and one entire field office equipment excessively damaged. Two months were spent in passing all the telegraph stores over this link in the route, but by keeping elephants ready at Demagiri, at the head of the navigable river, to carry forward the stores as soon as they were landed, no delay was, fortunately, incurred in the progress of the telegraph with the advance of the troops. The elephants were employed on the first stage out of Demagiri for 9 miles to the Tuichang river. In addition, 70 mules were made over by the Transport Department for the use of the telegraph, and as the path was opened out by the troops, brought forward the wire, insulators, and office boxes to convenient depôts.

The wire used was the ordinary galvanised iron, weighing 300 lbs. per mile. It was in coils weighing each about 80 lbs., so that a mule could carry two. The small field insulators, and brackets for nailing to trees, were packed in cases, so that each package was of this weight also. A mule could take a box on each side of the pack saddle. The office equipment boxes were arranged similarly. The instruments were the ordinary Siemens relays, Morse sounders and keys, but of reduced size. The batteries, which will probably be superseded by the Hellensen dry cells, were of the Minotti pattern, of a small size, in vulcanite receptacles, and packed in teak wood cases. The only difficulty experienced in working was that occasioned by the badness of the "earths" on the summits of the mountains. It was often impossible to get a good earth near the signaller's hut, and when working, the signals sometimes appeared in a circuit other than that for which they were intended.

The plan of operations, so far as the telegraph work was concerned, was as follows:—An independent course was taken through the forest and rather away from the mule track which was being made by the troops, who were frequently using dynamite to remove obstacles, and felling enormous trees. Even for the telegraph wire it was found necessary to make a wide clearing, as the overhanging parasites could in no other way be brought down. The bamboos gave most trouble, as they grow very thick, have to be cut near the bottom, and fall across the track, making a barrier difficult for the successive working parties to cross, and from the way in which they are cut—diagonally—leaving sharp spikes sticking out of the ground against which mules are easily injured. The labour employed in the forest clearing was heavy; about 100 men with choppers and axes were told off daily for it. The wiring party came next. It was requisite to drag the wire off the portable reels over the fallen timber, as the reel could not conveniently be carried. The insulator and bracket fixing party worked side by side with the wiring party. Trees were left standing—stout ones by preference—at convenient intervals in the middle of the track, to which the brackets were nailed. The straining party came half a mile behind the wiring party, and with this it was of great importance that wire should not be strained too tight. A large factor of safety is necessary where immense trees frequently fall on the line. As a rule, therefore, blocks were dispensed with, and the wire was pulled up simply by two men with the end of a rope warped on to it. In the large ravines and valleys met with it would have been impossible to estimate the dip of the wire, and by the method employed safety was secured. By working apart from the road the line was preserved from accident, and by making judicious short cuts an office was opened out at each fresh camp as soon almost as the camp was formed. Military signallers were employed chiefly in the offices. A large number of non-commissioned officers and men from the various batteries and regiments in India are trained annually in telegraphy, and many of them attain a high standard of efficiency. They have in field offices, as well as in the civil establishments, proved most useful, and in the Lushai hills encountered cheerfully the uncomfortable and insalubrious conditions to which all were subjected.

The temporary huts for offices, as well as those for the use of the working parties, were of bamboo. It is dexterously split with a chopper, opened out, and flattened, and several are plaited so as to form a chess-board pattern. A large and strong mat is thus formed which forms the bottom or wall of a hut. The roof is made of smaller bamboos covered with leaves. Huts were indispensable, as the night fogs and piercingly cold winds rendered open-air bivouacs impossible. It was found that about one day in the week was occupied in building new huts as a fresh camp was made.

The health of all parties was always precarious during these operations. The lack of healthy food, the contrast in the climate of mountain summits and deep miasmatic valleys, the chill winds, all combined to produce fever, dysentry, and pneumonia, and the number of invalids was extraordinary. Among the minor inconveniences which could be tolerated were the mosquito, the sand fly, and the leech.

On the Chin side the wire was, in the season 1889-90, brought up to Haka. With the Lushai column it reached the easterly channel of the Koladyne River, about 75 miles from Haka. It was considered that to have completed the junction at a time when the rainy season was approaching would not have been of utility, and the cost of maintenance and supervision would have been excessive. Judging from later experience, it is not improbable that the main route through the Chin country to Burma will be from Manipur.

ELECTRIC TRACTION BY STORAGE BATTERIES.

IT may be safely stated that with few exceptions almost all types of accumulators, up to the present, have been constructed on the principle of a number of plates; the reason for this preferred mode of construction is obvious, as large surface must be provided in order to store up the electrical energy in a given space, and, on the other hand it is also necessary to produce an accumulator with the lowest possible internal resistance. The principle of plates seems to answer well the two purposes absolutely necessary in a practical accumulator. But it has been proved, from long experience, that when such accumulators are put to work, although the introduction of a large number of plates secures a means for large storage capacity, the evil of its own destruction is at the same time introduced in the same proportion; for instance, it is absolutely necessary for the equal electrical distribution in a cell, that the distances between the plates should be alike all through the entire construction, and this has been found an utter impossibility in spite of the best forms of separators used in the building up of the accumulators. Supposing such an accumulator were perfect in its mechanical construction, when first put to work, how long does it last? A few charges and discharges alter the whole of the conditions and destroy the uniformity of its internal construction with the fatal result of destroying the electrical distribution between the plates. The natural consequence follows: those plates or parts which come under closer proximity do greater work than those further apart, the current while under charge disintegrates those parts more rapidly, and the same evil is repeated while undergoing the discharge, in fact, while some portions still contain a good charge others are completely discharged, and when this inequality of action sets in, self-destruction goes on very rapidly day by day. To cope with such a difficulty appears perfectly hopeless in spite of the best supervision. It is like an internal cancer, which when once the malady has declared itself, can only be treated by a surgical operation, and the sooner the better; it seems indeed that plate accumulators from their very birth carry with them the germ of self-destruction. This should only be the result of natural law, like in everything else, but in an accumulator there is something more than self-destruction under ordinary circumstances, as the rapid disintegration which soon takes place in an accumulator bears no proportion to the amount of work performed; there must therefore be a radical fault in the principle of construction which has not yet been understood; or is it a parasite that exists in the very principle common to all plate accumulators, which cannot be cured? From practical experience and close observation it seems that this difficulty, which has so much prevented the universal application of accumulators, so indispensable for street traction, and in other fields no less important, is not an insurmountable obstacle, but in order to achieve the desired end the evils which are brought to play must be cut down to a minimum; each plate that constitutes a portion of a storage battery, notwithstanding that it plays its part for storing capacity, brings also its contribution towards distortion, resulting in rapid disintegration. It is therefore evident that if the number of plates be increased this evil is multiplied in proportion. If an accumulator could be constructed without plates there would be an absence of all those innate faults above mentioned, therefore the fewer the plates, the less cause for destruction. From past results it has been proved that it would be useless to attempt further running electric cars for commercial purposes, unless an efficient accumulator, capable of taking up high charges, and at the same time capable of discharging at any required rate, is worked out, and that such an accumulator, when put to actual work, would require no more attention during the first year than any other portion of the system, beyond cleaning of connectors and re-filling of cells from time to time; if after the first year renewal be necessary, such renewal should not exceed 15 per cent. of the original cost. It is evident that from past and recent events in this country, electric traction by storage batteries has made no progress, but rather the contrary, and it seems to point to the fact that the sole reason for the failure lies in the present type of accumulators as being a too costly an element as far as the maintenance and renewal is concerned. It may be safely stated that 50 per cent. of the total expenditure is absorbed in the accumulator department, although it has been stated over and over again that large electrical firms would undertake the maintenance of accumulators at a 1d. per car mile. If such were a fact, there would not be a single car drawn by horses in this country, without mentioning any other country where electric traction by storage batteries has come to a standstill after exhaustive trials everywhere on account of the same old story, viz., the too costly maintenance of accumulators. How little feasible is the 1d. per mile theory in the light of a remark passed a short time ago by a gentleman in this country, largely interested in electric traction, in reference to accumulators, viz.: "We patch them up during the night and the following day the patches come off." It seems beyond discussion that from all points the present types of storage batteries are totally unsuited for practical work, especially for tram car propulsion, where so much strain is required to be sustained with impunity in order to compare favourably with the present cost of horse haulage.

THE COST OF LIGHTING BY ARC LAMPS FROM SMALL POWER STATIONS.

THE charge for arc lamps of 2,000 C.P. has been quoted from £15 to £25 per annum, according to the number of hours they are required to run; these prices include the cost of carbons and attendance, and the maintenance of the plant, in addition to interest on capital and a profit on the undertaking. That a large installation will pay, at even the lower figure, is undoubted; and the profit will be increased as the total output is enlarged and the time of lighting per lamp extended. These are more or less obvious facts, which have been demonstrated at a number of small supply stations in different parts of Great Britain. But in very few cases have tests of the mean commercial efficiency of plants been published in detail, the efficiency being understood to be the ratio of the electrical horse-power at the dynamo terminals to the indicated horse-power of the engines and the horse-power of the boilers. And yet this is most important knowledge in connection with any plant of which the power is sold either at a fixed rental or at a definite price per Board of Trade unit.

Dr. F. Bedell, of Sibley College, U.S., has just made a very exhaustive test of an arc lamp plant, and has published the figures in the *Electrical World*, of New York. The tests are of special interest, since they refer to a class of machinery largely used for small stations. The steam plant consists of two horizontal return tubular type boilers and two high-speed horizontal non-condensing engines, each with a single cylinder 10 inches in diameter and 12 inches stroke, and rated at 60 horse-power. The governors are of the fly-wheel type, and worked on to slide valves, so as to vary the cut off. The whole of the steam plant was supplied by the Ball Engine Company, of Erie, Pa. The dynamo plant comprises four Brush arc lighters. Dynamo I. is a 65-light machine with a 14 mile circuit, and 61 arc lamps. Dynamo II. is a 30-light machine, with a four mile circuit of 23 lamps.

Dynamo III. is also a 30-lighter, and has a two mile circuit with a mixed load: 12 arc lamps of 200 C.P. each; 10 Bernstein 100 C.P. incandescence lamps and 30 50-C.P.; and a few Swan lamps of 16 and 32-C.P. are at times used in this circuit in multiple arc.

The conditions, although not identical with those of an English station, are sufficiently similar to make a comparison profitable. Tests were made on four successive days under the ordinary working conditions, and the mean of the readings on each day was taken as characteristic of that day's work. The runs lasted from the starting of the engines until midnight, when the plant is shut down; and readings were taken every quarter of an hour.

The figures of the mean electrical measurements are as follows:

Mean Electrical Measurements.

	Volts.	Amps.	Watts.	E.H.P.
Dynamo I.... ...	2,596	8·53	22,080	29·6
Dynamo II. ...	797	9·49	7,580	10·2
Dynamo III. ...	1,130	9·7	10,960	14·7

Mean electrical horse-power, 54·5.
Mean indicated horse-power, 92·6.
Ratio of electrical horse-power to indicated horse-power, E.H.P. ÷ I.H.P. = 54·5 ÷ 92·6 = 59 per cent. = all day efficiency.

To obtain efficiency at full load, we take measurements taken at some time early in the evening.

Electrical Measurements, 9·15 p.m.

	Volts.	Amps.	Watts.	E.H.P.
Dynamo I.... ...	2,600	8·5	22,100	29·6
Dynamo II. ...	805	9·5	7,648	10·3
Dynamo III. ...	1,240	9·7	12,028	16·2

E.H.P., 56·1 ÷ I.H.P., 91·8 = 61 per cent. efficiency on full load.

And the tests of the engine and boiler plant are given below :—

Commercial results.	For engines alone.					For whole plant.
	Run 1.	Run 2.	Run 3.	Run 4.	Average.	
Fuel burned, lbs.						
Per hour	441·	415·	458·	424·	436·5	443·8
Per I.H.P. p. hr.	4·76	4·48	4·93	4·57	4·685	4·763
Per E.H.P. p. hr.	8·10	7·62	8·41	7·88	7·978	8·111
Lbs. combustible.						
Per hour	340·4	316·	368·20	349·	343·4	349·1
Per I.H.P. p. hr.	3·67	3·41	3·97	3·77	3·705	3·767
Per E.H.P. p. hr.	6·25	5·80	6·76	6·42	6·408	6·515
Pounds feed water.						
Per hour	3,596·	3,345·	3,575·	3,508·	3,506·	3,554·
Per I.H.P. p. hr.	38·8	36·1	38·5	37·8	37·80	38·432
Per E.H.P. p. hr.	65·8	61·4	65·6	64·4	64·30	65·37
Pounds dry steam from and at 212°.						
Per hour	3,475·	3,260·	3,493·	3,457·	3,421·	3,478·
Per I.H.P. p. hr.	37·4	35·2	37·6	37·2	36·85	37·46
Per E.H.P. p. hr.	63·7	59·9	64·1	63·2	62·73	62·78
Boiler H.P. ...	110·	108·6	117·3	108·	111·	111·
Efficiency of boiler, per cent.	73·1	70·8	73·	70·1	71·75	71·75
Mean I.H.P. ...	92·60	91·37	85·45	91·98	90·35	90·35
Efficiency of station, per cent.	59·	60·	63·	59·5	60·40	60·40

It will be seen that the ratio of mean electrical output to mean boiler horse-power is $\frac{54·5}{111}$, which equals 50 per cent., nearly. This is a very satisfactory result for such a plant.

The fuel used was anthracite coal. The boiler data for the first day is as follows :—

*Boiler Log *—First Run.*

Diameter of boiler, feet	5
Length of boiler, feet	15
Heating surface, square feet	2,060
Grate surface, " "	48·88
Ratio grate to heating surface	42·14
Character of draught	natural.
Temperature external air	38°
" boiler room	76°
Duration of test, hours	6
Water gauge at beginning...	5·05
" " " end	5·05
Total fuel weighed out, pounds	2,800
Fuel not burned, pounds	112
Fuel burned "	2,688
Total ash	572
Moisture in 100 lbs.	2
Weight combustible	2,074
Kind of coal...	anthracite.
Fuel per square feet grate...	51·97
Combustible per square feet grate	42·5
Per cent. entrained water...	3·4
Total water supplied	21,910
Dry steam per hour from temp. feed water	3,527·5
" " " and at 212°	3,792·0
" from and at 212° per pound coal	8·47
" " " " " combustible ...	10·97
" " " " square feet grate	77·5
" " " " heating surface	1·84
Thermal units per hour from coal supplied	5,012,650
" " " steam delivered	3,665,317
Horse-power	110
Efficiency of boiler...	73·1
Friction of north engine with belt off, per cent.... ...	6·9
" south " " "	6·6
" " " one dynamo, per cent. ...	9·8
" " " two dynamos, per cent. ...	14·7

* Log of two boilers considered as one.

THE BUCKING OF STREET RAILWAY MOTORS.

RAILWAY street men have noticed that occasionally an electric car will stop suddenly as if by a collision, and frequently will then go ahead again as if nothing had happened, although in a few cases the motors refuse to budge although a large current is flowing. This is fancifully called "bucking." There are all degrees of bucking, from a small jerk as if the car had run over a stone, to a complete stoppage that throws the passengers out of their seats, and has been known to send the driver over the dash board. These freaks, however, are not common ; but their recurrence will be more frequent as the number of trolley cars is increased, if the causes are not investigated and removed. The subject was deemed sufficiently important to bring before the American Institute of Electrical Engineers some few months ago ; and Prof. Geo. D. Shepardson has recently contributed an able article on bucking to the *Electrical World* of New York.

To fully understand how this peculiar action is possible it is necessary to carefully note the method of coupling up the motors generally adopted in the United States. This is shown in fig. 1. It is seen that the current from the trolley

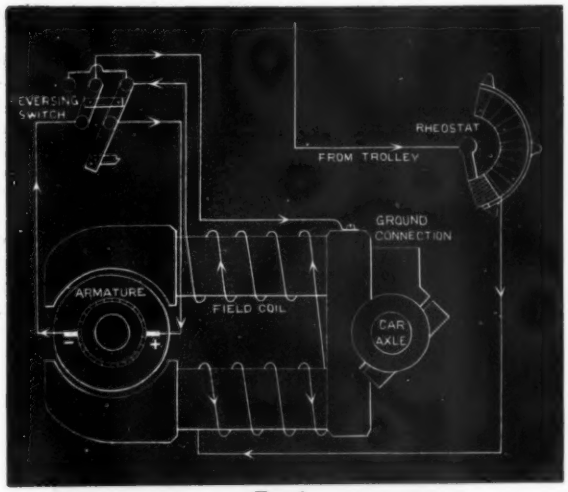


FIG. 1.

enters through a starting resistance, and then passes around the field windings, next to a reversing switch, through the armature, back again to the switch, and finally is earthed through the framing of the motor. Fig. 2 shows the

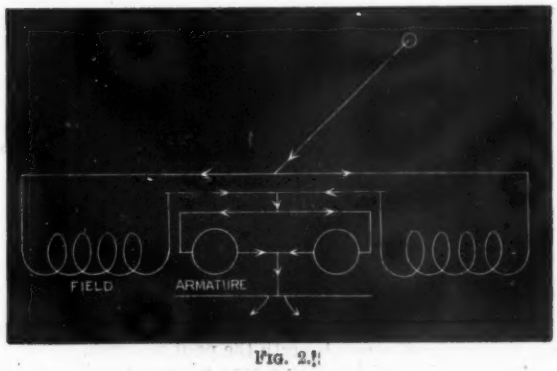


FIG. 2.

arrangement schemmatically, when two motors are coupled in parallel, and a single reversing switch is used. Fig. 3 gives the same arrangement with two reversing switches. When commutated fields are employed the diagram is similar to fig. 2. In each of these figures the switches and rheostats are omitted.

Another point to note is that since the machines are always series wound, the direction of rotation must be reversed, if the motor is to act as a generator. And as a corollary it follows that if, from any cause, one of the motors tends to act as a generator, it will give a current in the opposite direction to the main trolley current, and will tend

to "slow" the other machine, the armature of which is in parallel with it. Now in nearly all authentic cases of bucking, where the cause has been traced by competent engineers, a short circuit has been found; this may have been of a temporary or permanent character, the essential point is the fact of the short circuit.

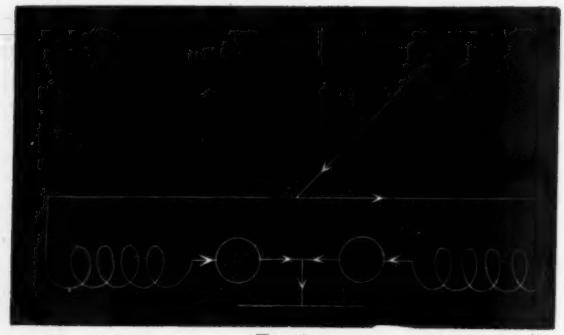


FIG. 3.

Bucking in its simplest form is illustrated in fig. 4. Here there is supposed to be a connection between the positive brush leads and the frame of the machine, as indicated by the dotted line at *e*. The effect of this will be to cut the armature out of circuit and to considerably increase the current through the field coils. The armature would stop if free to do so, but its rotation is constrained by the momentum of the car and perhaps by the second motor as well. Thus the machine is virtually a separately excited dynamo *on short circuit*, and may generate a large current in the reverse direction to the main current from the trolley, as indicated by the dotted arrows, and the power required to drive it will be sufficiently great to pull the car up immediately, as if a powerful brake had been suddenly applied to the four wheels. The above type of accident is sometimes caused by a loose

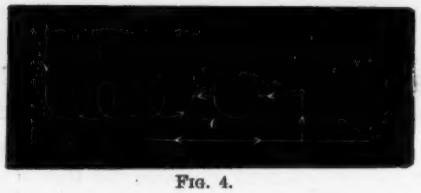


FIG. 4.

wire and the shock may remove the contact, in which case the car will at once run smoothly and the source of trouble may not be detected. If, however, the ground is permanent the buck will be so hard that the motor-man has to shut off the current and inspect the machines. One commutator will be found to be blackened and burnt. That will guide him, and the "short" can perhaps soon be repaired by a piece of insulation tape, or the motor must be cut out of circuit by removing the brushes and disconnecting the field windings.

It is obvious that the same brake action will result if the motor be grounded at another point between the positive brush holder and the field. Carbon dust, mud or water, on the brush holder may also cause a short circuit which would probably be burnt out by the first rush of current.

A ground on the armature itself will cause intermittent bucking, for there will be a partial short circuit every time the damaged coil comes beneath the positive brush.

Another class of bucking occurs when a car is running down hill with current on, the jerk occurring at the instant the circuit is opened. Such may be caused by the jumping of the trolley, or by the car passing over a dead rail or a dirty track. The reason for this is not very obvious, but it is no doubt due to the unequal action of the two motors. Although the two machines may originally have been carefully selected to work in parallel, yet the joints between the magnet and yoke faces are rarely made so nicely when the motor is taken to pieces for cleaning or repairs as they were in the erecting shop of the manufacturer, and hence the magnetic fields tend to get more unequal every time the motors are taken to pieces. Now, for a given voltage the speed of a motor will vary inversely as the strength of the magnetic flux; and hence although the excitation may be the same in each field winding, yet the two machines will tend to run at different speeds, and the "freer" motor will have to do work on the "lagging" one. This extra work will cause an E.M.F. in the latter which will tend to drive current in the opposite direction to the trolley current, and hence may stop both motors and so brake the car. Careful tests show that this negative current is sometimes as high as 30 ampères."

One bucking car gave, on testing, the following results:—

Head motor.	Rear motor.
55	38
23	0
21	− 1
0	− 4

A single reversing switch was used, and the ammeters showed that the main current divided equally between the two fields. On reversing the car the difference was not so marked, thus showing that the adjustment of the brushes partly explained the difficulty. This class of error is most apparent at medium loads, and is scarcely appreciable when the car is running light.

Again, consider the case in which the motors are connected by an equaliser, as in fig. 2, or by a single reversing switch, and in which one motor does more work than the other. Suppose the car to be running at a moderate speed and one armature to be *generating* 6 ampères or more, and let the circuit be suddenly opened in any of the ways mentioned. The weak field will lose its magnetism first, and so the counter E.M.F. of its armature will die away before that of the other armature. The latter will then act as a generator and drive current through the other armature circuit, and this will brake the motor and check the car. The effect is illustrated in fig. 5. When the trolley circuit is opened, the

FIG. 5.

current ceases to flow in the fields, but the residual magnetism is sufficient to cause the armatures to generate a certain quantity of current.

A buck of a similar character occurs if a single reversing switch be used and one of the field circuits be broken. In one experiment the field circuit of the head motor was broken when the car was running at full speed. The head motor at once took 150 ampères, of which the rear machine generated 80. The car quickly slowed down to a speed of about two miles per hour, taking from 70 to 90 ampères in the head armature, while the rear one generated between 20 and 40 ampères. In this case the current in the head armature set up its own field by induction. This kind of accident occurs with cars in regular service through field connections breaking or getting loose.

There are probably other causes for bucking not covered by the preceding remarks, but they can all be explained if reliable data be given. The subject is being carefully investigated by street railroad authorities, and soon proper instructions will be issued to motor-men.

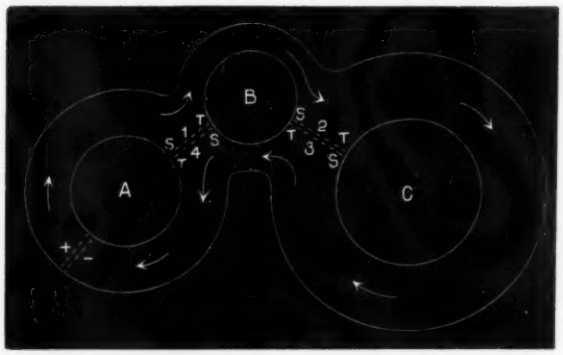
The risk of bucking from grounds can be largely reduced by coupling the armature between the trolley and the field, instead of between the field and earth; for then a "short" on the fields would simply cut out part of the coils and cause the motor to absorb more current; and a ground on the armature would cause the fuse to blow. Indeed, with such a coupling, the only true bucking would perhaps be with flashing over. The objection to it is that lightning discharges would be likely to damage the armatures instead of a field coil, as usually happens with the old arrangement, and the disadvantage of a burnt out armature may be of more importance than the inconvenience of bucking.

TO DRAW A MERCATOR CHART ON ONE SHEET REPRESENTING THE WHOLE OF ANY COMPLEXLY CONTINUOUS CLOSED SURFACE.

BY LORD KELVIN, P.R.S.

IF a solid is not pierced by any perforation, its surface is called simply continuous, however complicated its shape may be. If a solid has one or more perforations, or tunnels,* its whole boundary surface is called "complexly continuous"; duplexly when there is only one perforation; $(n + 1)$-plexly when there are n perforations. The whole surface of a group of n anchor rings (or "toroids") cemented together in any relative positions is a convenient and easily understood type of an $(n + 1)$-plexly continuous closed surface.

Let the diagram represent a quadruplexly continuous closed surface made of very thin sheet metal, uniform as to thickness and homogeneous, as to quality, throughout. To prepare for making a Mercator chart of it, cut it open between perforations C and B, B and A, A and outer space, in the manner indicated at $\frac{2}{3}$, $\frac{1}{4}$, and $\pm$. Apply infinitely conductive borders to the two lips separated by the cut at $\pm$, and apply the electrodes of a voltaic battery to these borders. By aid of movable electrodes of a voltmeter trace, on the metallic surface, a very large number $(n - 1)$ of equidifferent equipotential closed curves between the + and − borders. Divide any one of these equipotentials† into parts each equal to the infinitesimal distance perpendicularly across it to the next equi-potential on either side of it; and through the divisional points draw curves cutting the equipotentials at right angles. These curves are the stream lines. They and the $(n + 1)$ closed equipotentials (including the infinitely conductive borders) divide the whole surface into $n\ m$ infinitesimal squares, if m be the number of divisions which we found in the equipotential. The arrows on the diagram show the general direction of the electric current in different parts of the complex circuit; each arrow representing it for the thin metal shell on either far or near side of the ideal section by the paper.



Considering carefully the stream lines in the neighbourhoods of the four open lips marked in order of the stream, 1, 2, 3, 4, we see that for each of these lips there is one stream line which strikes it perpendicularly on one side and leaves it perpendicularly on the other, and which I call the flux-shed-line (or, for brevity, the flux-shed), for the lip to which it belongs. The stream lines infinitely near to the flux-shed, on its two sides, pass infinitely close round the two sides of the lip, and come in infinitely near to the continuation of the flux-shed on its two sides. Let F_1, F_2, F_3, F_4 (not shown on the diagram) be the points on the + terminal lip, from which the flux-sheds of the lips 1, 2, 3, 4, proceed, and let G_1, G_2, G_3, G_4 be the points at which they fall on the − lip. Let S_1, T_1, S_2, T_2, &c., denote the points on the four lips at which they are struck and left by their flux-shed lines.

Let p_1, l_1, p_2, l_2, p_3, l_3, p_4, l_4, p_5 be the differences of potential from the + lip to S_1, from S_1 to T_1, T_1 to S_2 . . . . S_4 to T_4, and T_4 to the − lip. Measure these nine differences of potential. We are now ready to make the Mercator chart. We might, indeed, have done so without these elaborate considerations and measurements, simply by following the rule of my previous article; but the chart so obtained would have infinite contraction at eight points, the points corresponding to S_1, T_1, . . . S_4, T_4. This fault is avoided, and a finite chart, showing the whole surface on a finite scale in every part, is obtained by the following process.

Take a long cylindric tube of thin sheet metal, of the same thickness and conductivity as that of our original surface, and on any circle, H, round it, mark four points, h_1, h_2, h_3, h_4, at consecutive distances along its circumference, proportional respectively to the numbers of the m stream lines, which we find between F_1 and F_2, F_2 and F_3, F_3 and F_4, F_4 and F_1 on the + lip of our original surface. Through h_1, h_2, h_3, h_4, draw lines parallel to the axis of the cylinder.

Let now an electric current, equal to the total current which we had from the + lip to the − lip through the original surface, be maintained through our present cylinder by a voltaic battery, with electrodes applied to places on the cylinder very far distant on the two sides of the circle H. Mark on the cylinder eight circles, K_1, K_2, . . . K_8, at distances consecutively proportional to $l_1, p_2, l_2, p_3, l_3, p_4, l_4$, and absolutely such that l_1, p_1, &c., are equal to the differences of their potentials from one another in order.

Bore four small holes in the metal between the circles K_1 and K_2, K_3 and K_4, K_5 and K_6, K_7 and K_8, on the parallel straight lines through h_1, h_2, h_3, h_4 respectively. Enlarge these holes, and alter their positions so that the altered stream lines through h_1, h_2, h_3, h_4 (these points supposed fixed, and very distant), shall still be their flux-sheds. While always maintaining this condition, enlarge the holes and alter their positions until the extreme differences of potential in their lips become l_1, l_2, l_3, l_4, and the differences of potential between the lips in succession become p_2, p_3, p_4. In thus continuously changing the holes we might change their shapes arbitrarily; but to fix our ideas, we may suppose them to be always made circular. This makes the problem determinate, except the distance from the circle, h_1, h_2, h_3, h_4, of the hole nearest to it, which may be anything we please, provided it is very large in proportion to the diameter of the cylinder.

The determinate problem thus proposed is clearly possible, and the solution is clearly unique. It is of a highly transcendental character, viewed as a problem for mathematical analysis; but an obvious method of "trial and error" gives its solution by aid of electric measurement, with quite a moderate amount of labour if moderate accuracy suffices.

When the holes have been finally adjusted to fulfil our conditions, draw, by aid of the voltmeter and movable electrodes, the equipotentials for p_1 above the greatest potential of lip 1, and for p_5 below the least potential of lip 4; and between these equipotentials, which we shall call f and g, draw $n - 1$ equidifferent equipotentials. Draw the stream lines, making infinitesimal squares with these according to the rule given above in the present article. It will be found that the number of stream lines is m, the same as on our original surface; and the whole number of infinitesimal squares on the cylinder between f and g is $m\ n$. Cut the cylinder through at f and g; cut it open by any stream line from f to g; and open it out flat. We thus have a Mercator chart bounded by four curves, cutting one another at right angles, and divided into $m\ n$ infinitesimal squares corresponding individually to the $m\ n$ squares into which we divided the original surface by our first electric process. In this chart there are four circular blanks corresponding to the lips 1, 2, 3, 4 of our diagram; and there is exact correspondence of their flux-sheds and neighbouring stream lines, and of the disturbances which they produce in the equipotentials, with the analogous features at the lips of the original surface as cut for our process. The solution of this geometrical problem was a necessity for the dynamical problem with which I have been occupied, and this is my excuse for working it out, though it might be considered as devoid of interest in itself.

* A "hole" may mean a deep hollow, *not* through with two open ends. The word "tunnel" is inappropriate for the aperture of an anchor ring. Neither "hole" nor "tunnel" being unexceptionally available, I am compelled to use the longer word "perforation."

† Two sentences of my previous article ("Generalisation of Mercator's Projection"), in §3, and in last paragraph but one, are manifestly wrong, and must be corrected to agree with the rule given for dividing into infinitesimal squares, in the present text.

WATER POWER.

BY E. TREMLETT CARTER.

(*Continued from page* 375.)

VII.

24. *Undershot Wheels.*—It commonly occurs that a rapid stream, developing considerable momentum in a high, mountainous country, crosses swiftly some low-lying level plain with little or no fall in vertical height, overcoming the friction of its bed by its great momentum. Such streams are frequently, and especially in the rainy season, level with the surrounding flat country, and would, if ponded back so much as a few inches, cause a flood over a considerable area of land. Yet these streams carry with them no small amount of kinetic energy, which if properly utilised would enable useful work to be done. There is only one type of engine which is capable of utilising that energy; it is the undershot wheel. Strictly speaking, this engine develops useful power in virtue of impulse alone, there being no fall within the wheel; but there are wheels which, working on a steep race, are actuated by weight to some small extent, though, from their general construction, they resemble and are called undershot wheels. In this type of engine the water is conducted along a straight race, which forms an uninterrupted continuation of the head race and passes imperceptibly into the tail; the water striking a number of flat floats as it passes under the wheel. When this wheel race is horizontal the action is one of pure impulse; but when, as is sometimes the case, the race is inclined, the water under the wheel has a slight action on account of its weight.

The most common form of undershot wheel consists of a pair of wooden crowns, braced together with wooden stanchions and a number of radial floats. The floats are merely flat planks of timber, and are occasionally set at a slight feather. There is no sole, so that there is free escape of air between the back of the floats. The power is occasionally taken off at the rim, though more frequently at the centre by means of a cast-iron or wooden shaft. From paragraph 19 it will be seen that the efficiency of these wheels cannot exceed 50 per cent., since the water must pass away with the velocity of the wheel; and that the best conditions are fulfilled when the wheel is moving with half the velocity of the water in the head race. In practice, when this condition of relative velocity is provided, the commercial efficiency will be about 30 to 35 per cent. There are several sources of loss besides those due to impulse and the residual kinetic energy of the water. These are, principally, the escape of water under the wheel in the clearance between the floats and the race bed, the escape of water at the sides of the wheel, and the backwater pressure due to imperfect feathering and the ponding in the tail-race. The amount of clearance depends on the degree of screening which the water gets before entering the engine, and on the liability of the timber to warping. If the wheel is made of well seasoned timber, and is never allowed to stand dry, and if the grating is of small mesh, the clearance need not be more than 1 inch; on the other hand, it is often as much as 3 or 4 inches. The escape of water round the sides of the wheel can be made very small if the wheel is to be almost as wide as the stream, for the small amount of damming which will be necessary will not usually affect the top water level to any serious extent. When the wheel is required to develop only a small proportion of the power of the stream, the escape of water round the wheel is of no importance, and forms a natural means for the passage of the unused water. It would, in this latter case, be unfair to credit this loss to the inefficiency of the engine. Where the whole stream is to be utilised, the clearance between the wheel and the side of the race may be as low as 2 inches if collars are placed on the shaft to take off the end play. Backwatering in the tail race may be prevented by feathering the floats (paragraph 23), and by lowering the level of the bed of that race so as to bring the water in the tail to the same level as that in the head race. Since the water in the tail is moving slower than that in the head race, the depth in the former will be greater than in the latter; and a comparison of figs. 28 and 29 will show that by lowering the bed of the tail race the backwatering tendency of the water may be removed. In the former diagram the floats are acted on by a back pressure due to the head $(D - d)$, in the latter that head does not exist. It is not always possible to cut away the tail race in this manner, for, where the natural stream is very level, lowering the tail bed will only cause an accumulation of water and will not reduce the level of the tail water. This device can, on that account, be used only where a slight fall can be developed. The diameter of a wooden undershot wheel is usually from six to eight

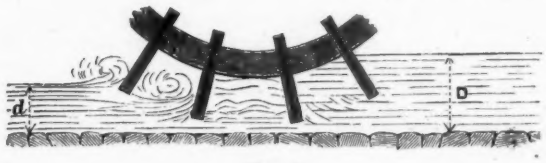


FIG. 28.

times the head. The number of floats should be large, in order fully to utilise the pressure of the stream under the wheel. There should be at least three or four floats in the water at any instant. The usual practice seems to be to make the number of floats about three or four times the dia-

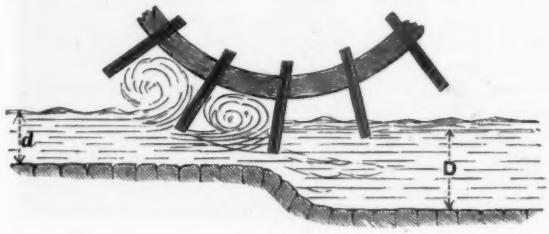


FIG. 29.

meter of the wheel, though there is considerable divergence between English and continental practice. Some wheels in Sweden have as many as 24 floats to the foot of diameter.

25. *Poncèlet's Wheel.*—Where undershot wheels are to be

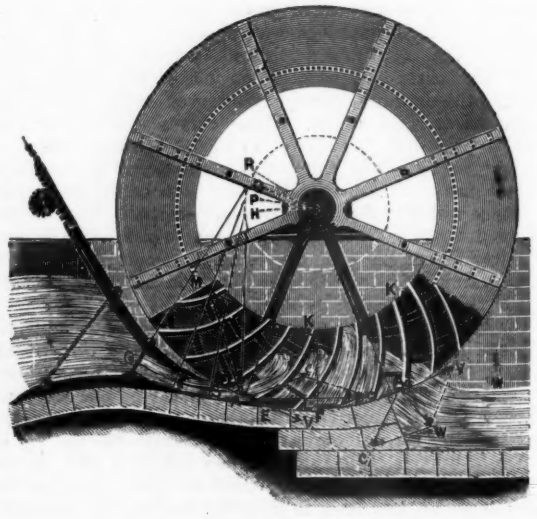


FIG. 30.

erected for the purpose of developing electric power, it would generally be better to use a more efficient form of engine than the wooden wheel described in the last section. A very good engine for low heads, and one which develops a much higher efficiency than the wooden wheel, is that known as the Poncèlet wheel. In classifying this with undershot wheels I am aware that many have disputed its connection with water-wheels, and have classified it with turbines. On the other

hand, authorities have not been wanting who have placed the Poncèlet wheel among water-wheels. Adopting the system of classification mentioned in paragraph 17, we shall find it correct to place this engine with the form of water-wheel under present consideration.

The truth seems to be that the Poncèlet wheel is both a turbine and an undershot wheel; for in its action it resembles the action of the former, while in the general form of its arrangement and structure it is decidedly the latter. A diagram of this engine, showing a portion of one of the crowns removed, is given in fig. 30. It will be seen that the floats are curved, so that the water glides on to them and glides off of them at a slight angle. The purpose of this essential feature of the wheel is to utilise more of the impulse of the water than could be utilised where the water is allowed to escape with the velocity of the wheel.

A little consideration will show that when the water is coming down the floats, and is about to leave the wheel, it is moving almost exactly in the opposite direction to the wheel. Now, if it moves in this direction with the same velocity relatively to the wheel as the wheel itself is moving, it follows that the water is leaving the wheel with the minimum velocity relatively to the earth. The energy which the water carries away depends on its velocity relatively, not to the wheel, but to the earth, so that, by curving the floats, the water is made to give up almost all of its energy, carrying away only a very small amount on account of its vertical motion downwards to the tail race. To obtain this there must be a definite relation between the curvature of the floats and the velocities of the water and wheel. As the theory of this relation forms a good basis to the theory of turbines, we will consider it mathematically.

Adopting the same meanings for the symbols as before, and writing v_r for the relative velocity of the water with respect to the wheel, on entering, we have

$$v_r = \sqrt{v^2 + v^2 - 2\,v \,.\, v \,.\, \cos a}$$

And

$$\sin \beta = \frac{v}{v_r} \,.\, \sin a.$$

If the vanes are so set that the water glides on to them quite tangentially, the water will commence to ascend the vanes with this velocity, exerting a pressure in the direction of motion of the wheel and coming to rest near the top of the vanes. This will occur during the motion of any one vane from A to F. The water now descends the vane, acquiring the absolute velocity

$$v_2 = \sqrt{v_r^2 + v^2 - 2\,v_r \,.\, v \cos \beta}.$$

The kinetic energy with which it leaves the wheel at A_1 is, therefore,

$$E_2 = \frac{62{\cdot}4\ Q\ (v_2)^2}{2\,g}$$

Since its original kinetic energy was

$$E_1 = \frac{62{\cdot}4\ Q\ v^2}{2\,g}$$

the work done has been

$$W = E_1 - E_2.$$

Substituting in terms of a, we get

$$W = \frac{62{\cdot}4\ Q}{g} \,.\, 2\,v\,(v \cos a - v).$$

This will be a maximum when a is equal to zero, and when the velocity of the wheel is equal to half that of the entering water. Under these conditions the relative velocity of the water as it leaves the wheel would be

$$v_r' = \sqrt{(v - v)^2 + 2\,v^2 - 4\,v\,(v - v)} = -\,v$$

and its absolute velocity

$$v_2 = \sqrt{v_r^2 + v^2 - 2\,v_r \,.\, v} = 0.$$

It would convey away no kinetic energy, and the efficiency of the wheel would be 100 per cent. In practice the water must leave with some velocity, for the angle a cannot be zero, but must be about 15 or 20°; in which case the most economical conditions are fulfilled by running the wheel so that the velocity of discharge takes place wholly along a fixed radius of the wheel. Then

$$v_r' \,.\, \cos \beta = -\,v,$$

and

$$v_2 \,.\, \cos \beta = 0.$$

Assuming that the curved vanes are constructed and set properly, so that there is no shock to the entering stream nor escape of water at the top of the vanes (the lip of the vane being set at the angle, β), then the whole of the work done is usefully developed in the wheel, and the H.P. is

$$\text{H.P.} = \frac{62{\cdot}4\ Q}{550\ g} \,.\, 2\,v\,(v \cos a - v)$$

About 80 to 85 per cent. of this will be available outside the wheel for doing external work.

In order that the whole thickness of the entering jet shall pass into the wheel at the required angle, the guide race must be curved as shown in fig. 30, at G, T, S, A. The proper curve is the evolute of a circle having the same centre as the wheel, the generatrix being initially at right angles to the direction of the water, A, A_1. The successive positions of the generatrix are shown in the diagram by the lines, A H, S P, T Q and G R, the construction of the curve being clearly indicated by the figure. The sluice is curved at the lower lip, so as to form the upper surface of the guide channel, the curve of the sluice being similar and geometrically parallel to that of the bed. The depth of the entering stream at full load should not exceed one-fifth of the head for which the wheel is constructed. The height to which the water will ascend on the vanes is equal to the original head, less the head due to the velocity of the wheel, with a slight reduction on account of the centrifugal action on the water. It is usual to make the radial depth of the vanes about three-quarters of the head, which will generally allow a little clearance between the water and the top. With wheels running faster than half the current, the depth may be less than this, and is sometimes about half the head.

The vanes, as well as every other part of the wheel, are usually made of wrought-iron or mild steel. They are most easily made in cylinders and cut into the required size for the wheel, care being taken to set them in the crowns at the proper angle at the lip. The radius of curvature of such vanes may be 0·7 of the head, and from three to five vanes per foot of diameter of the wheel may conveniently be used. The wheel is usually about four times the head in diameter.

26. *Regulation.*—The methods of regulation will be discussed in the next section under the head of *governors*, but something must be said about the principles of regulating water-wheels. Considering only the requirements of electric power we find that wheels are used under conditions which may or may not require automatic regulation. Where water power is used to develop electric currents for charging cells, there being no lamps on the mill, hand regulation is sufficiently prompt and effective; but where a steady voltage is to be maintained on a circuit in which the demand may vary several hundreds per cent. in a few seconds, automatic regulators or governors must be placed in control of the water supply. Hand regulation may be divided into two classes; the first, in which the supply of water is regulated; the second, in which the water is kept at full gate, but the supply of power to the machine or to the cells is regulated. English practice is almost, if not wholly included in the first class, and consists in raising or lowering the gate according to the condition of top level and the need of more or less power. In America this is also done very largely, but it is also extensively the practice there to keep the gate full open all the time and to regulate by absorbing the surplus power. Electric resistance frames, which can be switched into or out of the circuit by hand, are very commonly used for this purpose. For instance, if a water-wheel develops 20 H.P. at full gate and is, at any time, required to develop only 5 H.P., it would be kept at full gate, and 15 H.P. would be absorbed by resistances. This seems very wasteful practice, but it is defended on the ground that if the water were not run through the wheel it would run through the by-wash or get away in some other manner, and it is just as well to get a little warmth out of it as to let it escape altogether. This reasoning is only correct if the water cannot be stored, or where there is at all times sufficient water to render storing unnecessary; but it would generally pay to shut down the sluices to a quarter gate and to keep the water in the pond till it was really wanted. Another American dodge is to put a brake on the machinery, with which to absorb the surplus power when only a fraction of the power developed is required; but this cannot be recommended on any grounds.

Where a water wheel is to be regulated automatically

great care must be exercised in selecting the position of the sluice. The promptness and efficiency of a governor very much depends on this position, for it depends on the volume of water which is intercepted at any time between the sluice and the tail race. Before the governor can have any appreciable effect on the wheel, the water which occupies the space between these two points must pass away, and this will take an amount of time depending on the distance between them. If there is a volume of 500 cubic feet at any instant in the space between the sluice and the point where the water is discharged from the wheel, including the guide-trough and the engine, and if the engine is taking 50 cubic feet per second, it is evident that the governor cannot act on the wheel till 10 seconds have elapsed from the time the sluice commences to change its amount of opening. Undershot wheels and low brest wheels will permit of much more prompt regulation than overshot wheels; because the latter hold so much more water and pass it on with less velocity (as measured in cubic feet per second per horse-power). In every case, however, the promptness depends on the proximity of the regulating sluice to the engine. The promptness of governing depends also on other influences. If the dynamo is driving a number of lamps and the number suddenly reduces to one-half, several changes must occur, and a considerable fraction of a second elapse, before even the governor can be affected by the change, and, as we have seen, a further interval must occur before the remedy is applied. If the governor is actuated by the engine, a change of speed must first occur in the dynamo, then in the connecting gear, then in the wheel itself; this will cause a change of speed in the governor, which must rise to some large amount (say 2 per cent.) before that instrument will think about acting, after which it begins to act on some form of supplementary gear, which may take a long or a short time to act on the sluice, according to the quality of its design. Then passes the interval necessary to clear out the water already in the engine. During all this time the voltage has been raised, and the lamps have been lighting above candle-power. Perhaps when the change comes that all this has taken place to inaugurate, the dynamo no longer requires it. An important principle in the successful and prompt regulation of water-wheels is, then, that there should be as little machinery to operate and as little water to control as possible, that the governor should be acted on as soon as possible after the need for change has arisen, and that it, in turn, should act as soon as possible on the engine. This will best be obtained by controlling the governor from the terminals of the dynamo, or from the omnibus bars of the switchboard, and by placing the sluice close to the engine.

(To be continued.)

ELECTRIC LIGHTING PROVISIONAL ORDERS AND LICENSES.

Report by the Board of Trade respecting the Applications to and Proceedings of the Board of Trade under the Electric Lighting Acts during the Past Year.

THE following applications for provisional orders have been received by the Board of Trade since the date of the last report:—

Title of Order and Description of Area.	Name of Promoters.
Aberystwith Electric Lighting Order. The Municipal Borough of Aberystwith.	Corporation.
Ashton-under-Lyne (Corporation) Electric Lighting Order. The Municipal Borough of Ashton-under-Lyne.	Do.
Brighton Electric Supply Order. A portion of the Municipal Borough of Brighton and the Parish of Preston.	Brighton and Hove Electric Light Company, Limited.
Dublin Electric Lighting Order. The City of Dublin.	Corporation.
Fareham Electric Lighting Order. The District of the Fareham Urban Sanitary Authority.	The Fareham Electric Light Company, Limited.
Govan Electric Lighting Order. The Burgh of Govan.	Commissioners of Police.
Halifax (Corporation) Electric Lighting Order. The County Borough of Halifax.	Corporation.
Harwich (Corporation) Electric Lighting Order. The Borough of Harwich.	Do.
Kilkenny Electric Lighting Order. The Municipal Borough of Kilkenny.	Do.
Limerick Electric Lighting Order. The Borough of Limerick.	Do.
Liverpool Electric Lighting Order. A portion of the City of Liverpool.	The Liverpool Electric Supply Company, Limited.
THE COUNTY OF LONDON:—	
County of London (North) Electric Lighting Order: — The Parish of St. Mary, Islington. The United Parish of St. James and St. John, Clerkenwell. The Parish of St. Luke, Middlesex. The District of the Holborn District Board of Works.	County of London Electric Lighting Company, Limited.
County of London (South) Electric Lighting Order: — The Parish of Lambeth. The Parish of St. George-the-Martyr, Southwark. The District of the Wandsworth District Board of Works.	County of London Electric Lighting Company, Limited.
East London Electric Supply (Hackney) Order. The District of the Hackney District Board of Works.	East London Electric Supply Company, Limited.
Hampstead Electric Lighting Order. The Parish of St. John, Hampstead.	The Vestry.
Lambeth Electric Lighting Order. A Portion of the Parish of Lambeth.	Do.
North London Electric Lighting Order. The District of the Hackney District Board of Works. The Parish of St. Luke, Middlesex. The Parish of Clerkenwell.	Camberwell and Islington Electric Light and Power Supply, Limited.
St. Mary, Islington, Electric Supply Order. The Parish of St. Mary, Islington.	Messrs. Sharp and Kent, 34, Victoria Street, S.W.
Shoreditch Electric Lighting Order. The Parish of St. Leonard, Shoreditch.	The Vestry.
South London Electric Lighting Order. The Districts of the St. Olave District Board of Works and the St. Saviour's District Board of Works, and the Parishes of St. George-the-Martyr, Southwark, and St. Mary, Newington.	Camberwell and Islington Electric Light and Power Supply, Limited.
West London Electric Lighting Order. The Parishes of Hammersmith, Fulham, and Battersea, and a portion of the District of the Wandsworth District Board of Works.	Putney and Hammersmith Electric Light and Power Supply, Limited.
Whitechapel District Electric Lighting Order. The District of the Whitechapel District Board of Works.	The Board of Works.
Maidstone Electric Lighting Order. The Borough of Maidstone.	Corporation.
Newbury Electric Lighting Order. The Borough of Newbury.	Do.
Oxford Electric Lighting Order. (Transferring to the Oxford Electric Company, Limited, the rights, powers, and obligations of the Electric Installation and Maintenance Company, Limited, under the Oxford Electric Lighting Order, 1890.)	The Oxford Electric Company, Limited.
Sheffield Electric Lighting Order. The Municipal and County Borough of Sheffield.	Sheffield Telephone Exchange and Electric Light Company, Limited.
Sutton (Surrey) Electric Lighting Order. The Urban Sanitary District of Sutton.	The Local Board.
Walton-on-Thames Electric Supply Order. A portion of the Parish of Walton-on-Thames.	Weybridge Electric Supply Company, Limited.
Waterford Electric Lighting Order. The Borough of Waterford.	Corporation
Waterford Electric Supply Order. The Borough of Waterford.	City of Waterford Electric Supply Company, Limited.

Title of Order and Description of Area.	Name of Promoters.
West Ham (Corporation) Electric Lighting Order. The County Borough of West Ham.	Corporation.
Woking Electric Supply Company Electric Lighting Order. The Parish of Horsell and part of the Parish of Chertsey.	Woking Electric Supply Company, Limited.

Of these applications (32 in number) 17 were made by local authorities, 14 by companies, and one by a firm of electrical engineers; 11 related to the county of London.

In one instance an application was received from the local authority, and another application from a company, for the same area. An order was granted to the local authority and the application of the company was refused.

The following statement shows the manner in which the various applications have been dealt with:—

Title of Order.	How dealt with.
Aberystwith Electric Lighting Order.	Order granted.
Ashton-under-Lyne (Corporation) Electric Lighting Order.	Do.
Brighton Electric Supply Order.	The promoters failed to produce the consent of the local authority or to satisfy the Board of Trade that it should be dispensed with, and the Board of Trade refused to grant the Order.
Dublin Electric Lighting Order.	Order granted.
Fareham Electric Lighting Order.	Order granted
Govan Electric Lighting Order.	Do.
Halifax (Corporation) Electric Lighting Order.	Do.
Harwich (Corporation) Electric Lighting Order.	Do.
Kilkenny Electric Lighting Order.	Do.
Limerick Electric Lighting Order.	Do.
Liverpool Electric Lighting Order.	Do.
THE COUNTY OF LONDON:—	
County of London (North) Electric Lighting Order.	Order granted for: The United Parish of St. James and St. John, Clerkenwell; the Parish of St. Luke, Middlesex; the District of the Holborn District Board of Works.
County of London (South) Electric Lighting Order.	Two Orders granted: One in respect of the Parish of St. George the Martyr, Southwark; the other in respect of the District of the Wandsworth District Board of Works.
East London Electric Supply (Hackney) Order.	The Board of Trade declined to grant the Order, as the promoters failed to satisfy them that they were in a position to discharge the duties and obligations that would be imposed upon them by the Order, if granted.
Hampstead Electric Lighting Order.	Order granted.
Lambeth Electric Lighting Order.	Do.
North London Electric Lighting Order.	The Order was granted on the understanding that before the introduction of the confirming Bill the promoters should satisfy the Board of Trade that they were in a position to discharge the duties and obligations that would be imposed upon them. They, however, failed to do so, and the Bill was not introduced.
St. Mary, Islington, Electric Supply Order.	The promoters failed to produce the consent of the local authority or to satisfy the Board of Trade that it should be dispensed with, and the Board of Trade refused to grant the Order.
Shoreditch Electric Lighting Order.	Order granted.
South London Electric Lighting Order.	The Order was granted on the understanding that before the introduction of the confirming Bill, the promoters should satisfy the Board of Trade that they were in a position to discharge the duties and obligations imposed upon them. They, however, failed to do so, and the Bill was not introduced.
West London Electric Lighting Order.	The Board of Trade declined to grant the order, as the promoters failed to satisfy them that they were in a position to discharge the duties and obligations that would be imposed upon them by the order, if granted.
Whitechapel District Electric Lighting Order.	Order granted.
Maidstone Electric Lighting Order.	Do.
Newbury Electric Lighting Order.	Do.
Oxford Electric Lighting Order.	Do.
Sheffield Electric Lighting Order.	Do.
Sutton (Surrey) Electric Lighting Order.	Do.
Walton-on-Thames Electric Supply Order.	The Board of Trade declined to grant the order, as the promoters failed to satisfy them that they were in a position to discharge the duties and obligations that would be imposed upon them by the order, if granted.
Waterford Electric Lighting Order (Corporation).	Order granted.
Waterford Electric Supply Order (City of Waterford Electric Supply Company, Limited).	An order was granted to the Corporation and this application was refused.
West Ham (Corporation) Electric Lighting Order.	Order granted.
Woking Electric Supply Company Electric Lighting Order.	Do.

Bills Nos. 1 to 3 were introduced into the House of Commons on April 11th to confirm the orders relating to Govan, Aberystwith, Ashton-under-Lyne, Halifax, Harwich, Limerick, Maidstone, Kilkenny, Newbury, Sutton (Surrey), West Ham and Woking (Horsell and Chertsey).

Bills Nos. 4 to 6 were introduced into the House of Lords on May 6th to confirm the orders relating to Dublin, Fareham, Liverpool, Oxford, Sheffield, Waterford, County of London (a portion of), Southwark, Wandsworth, Hampstead, Lambeth, Shoreditch, and Whitechapel.

Bills Nos. 1 to 3 received Royal Assent on June 20th. Bills Nos. 4 to 6 are still before Parliament.

The provisional orders granted by the Board of Trade last session and referred to in the last report were all confirmed by Parliament.

LICENSES.

The following applications for licenses have been received since the date of the last report, and are at present under consideration:—

Name of Company applying and Name of District.

The Ogmore Valley Electric Light and Power Supply Company. (A portion of the district of the Ogmore and Garw Local Board.)

The Shropshire Electric Light and Power Company, Limited. (A portion of the Borough of Shrewsbury.)

The Isle of Wight Electric Lighting Company, Limited. (The Urban Sanitary District of West Cowes.)

Appended is a list of the provisional orders confirmed by Parliament (prior to the present session) and of the licenses granted by the Board of Trade, since the passing of the Electric Lighting Act, 1882, showing those which have since been revoked or repealed.

HENRY G. CALCRAFT.

Board of Trade, *June 23rd*, 1892.

PROVISIONAL ORDERS WHICH HAVE BEEN REVOKED.

1883.

Title of Order.	To whom granted.
Aston Electric Lighting Order.	South Staffordshire Electric Lighting Company, Limited.
Balsall Heath Electric Lighting Order.	Do. do.
Barnes and Mortlake Electric Lighting Order.	Metropolitan (Brush) Electric Light and Power Company, Limited.
Barton, Eccles, Winton, and Monton Local Board Electric Lighting Order.	The Local Board.
Bermondsey Electric Lighting Order.	Metropolitan (Brush) Electric Light and Power Company, Limited.
Birkdale Electric Lighting Order.	The Local Board.
Birmingham Electric Lighting Order.	Incandescent Electric Lighting Company, Limited.
Cambridge Electric Lighting Order.	Provincial (Brush) Electric Light and Power Company, Limited.
Canterbury Electric Lighting Order.	South-Eastern (Brush) Electric Light and Power Company, Limited.

Title of Order.	To whom granted.
Chelsea Electric Lighting Order.	Metropolitan (Brush) Electric Light and Power Company, Limited.
Chiswick Electric Lighting Order.	Do. do.
Clerkenwell Electric Lighting Order.	Do. do.
Croydon Electric Lighting Order.	South-Eastern (Brush) Electric Light and Power Company, Limited.
Dudley Electric Lighting Order.	South Staffordshire Electric Lighting Company, Limited.
Dundee Electric Lighting Order.	Brush Electric Light and Power Company of Scotland, Limited.
Finchley Electric Lighting Order.	Metropolitan (Brush) Electric Light and Power Company, Limited.
Folkestone Electric Lighting Order.	South-Eastern (Brush) Electric Light and Power Company, Limited.
Gravesend Electric Lighting Order.	Do. do.
Greenwich Electric Lighting Order.	Metropolitan (Brush) Electric Light and Power Company, Limited.
Hackney Electric Lighting Order.	Do. do.
Hampstead Electric Lighting Order.	Ferranti-Hammond Electric Light Company of Hampstead, Limited.
Hanover Square District (London) Electric Lighting Order.	Swan United Electric Light Company, Limited.
High Wycombe Electric Lighting Order.	Provincial (Brush) Electric Light and Power Company, Limited.
Holborn Electric Lighting Order.	Metropolitan (Brush) Electric Light and Power Company, Limited.
Hornsey Electric Lighting Order.	Do. do.
Ipswich Electric Lighting Order.	Provincial (Brush) Electric Light and Power Company, Limited.
Islington Electric Lighting Order.	Metropolitan (Brush) Electric Light and Power Company, Limited.
Limehouse Electric Lighting Order.	Do. do.
Lowestoft Electric Lighting Order.	Provincial (Brush) Electric Light and Power Company, Limited.
Luton Electric Lighting Order.	Do. do.
Maidstone Electric Lighting Order.	South-Eastern (Brush) Electric Light and Power Company, Limited.
Margate Electric Lighting Order.	Do. do.
Norwich Electric Lighting Order.	The Corporation.
Poplar Electric Lighting Order.	Metropolitan (Brush) Electric Light and Power Company, Limited.
Redditch Electric Lighting Order.	Incandescent Electric Lighting Company, Limited.
Rochester Electric Lighting Order.	South-Eastern (Brush) Electric Light and Power Company, Limited.
Rotherhithe Electric Lighting Order.	Metropolitan (Brush) Electric Light and Power Company, Limited.
St. George the Martyr (Southwark) Electric Lighting Order.	Do. do.
St. George's-in-the-East Electric Lighting Order.	Do. do.
St. Giles's (Brush) Electric Lighting Order.	Do. do.
St. Giles's (Pilsen-Joel) Electric Lighting Order.	Pilsen-Joel and General Electric Light Company, Limited.
St. James's and St. Martin's (London) Electric Lighting Order.	Edison Electric Light Company, Limited.
St. Luke's Electric Lighting Order.	Metropolitan (Brush) Electric Light and Power Company, Limited.
St. Olave Electric Lighting Order.	Do. do.
St. Pancras (Middlesex) Electric Lighting Order.	The Vestry.
St. Saviour's (Southwark) Electric Lighting Order.	Metropolitan (Brush) Electric Light and Power Company, Limited.
Saltley Electric Lighting Order.	South Staffordshire Electric Lighting Company, Limited.
Scarborough Electric Lighting Order.	The Corporation.
Shoreditch Electric Lighting Order.	Metropolitan (Brush) Electric Light and Power Company, Limited.
South Kensington Electric Lighting Order.	Swan United Electric Light Company, Limited.
Strand District (London) Electric Lighting Order.	Do. do.
Sudbury Electric Lighting Order.	Provincial (Brush) Electric Light & Power Company, Limited.
Sunderland Electric Lighting Order	North-Eastern Electric Light and Power Company, Limited.
Ulverston Electric Lighting Order.	The Local Board.
Victoria District (London) Electric Lighting Order.	Swan United Electric Light Company, Limited.
Walsall Electric Lighting Order.	Incandescent Electric Lighting Company, Limited.
Wandsworth Electric Lighting Order.	Metropolitan (Brush) Electric Light and Power Company, Limited.
Wednesbury and Darlaston Electric Lighting Order.	South Staffordshire Electric Lighting Company, Limited.
West Bromwich Electric Lighting Order.	Do. do.
Whitechapel Electric Lighting Order.	Metropolitan (Brush) Electric Light and Power Company, Limited.
Wolverhampton Electric Lighting Order.	South Staffordshire Electric Lighting Company, Limited.
1884.	
Edison and Swan United Electric Lighting Order.	Edison and Swan United Electric Light Company, Limited.
Fulham District Electric Lighting Order.	West Middlesex Electric Lighting Company, Limited.
St. James's, St. Martin, and St. George, Hanover Square (West London) Electric Lighting Order.	West London Electric Lighting Company, Limited.
1890.	
Ashton-under-Lyne Electric Light and Power Order.	Municipal Electric Light and Power Corporation, Limited.
Lambeth Electric Supply Order.	House-to-House Electric Light Supply Company, Limited.
North London Electric Supply Order.	Do. do.
Wandsworth District Electric Supply Order.	Do. do.
Plymouth Electric Lighting Order.	Devon and Cornwall Electricity Supply Company, Limited.
Preston Electric Lighting Order.	National Electric Supply Company, Limited.
Preston and Fulwood Electric Lighting Order.	Lancashire and Cheshire House-to-House Electricity Company, Limited.
Sevenoaks Electric Lighting Order.	The Electric Trust, Limited.
Tunstall Electric Lighting Order.	Do. do.
1891.	
Ipswich Electric Lighting Order.	Laurence, Scott & Co., Limited.
Withington District Electric Supply Order.	Manchester House-to-House Electricity Company, Limited.

LICENSES REPEALED OR EXPIRED.

Title of License.	To whom granted.
1884.	
Colchester Electric Lighting License.	South-Eastern (Brush) Electric Light and Power Company, Limited.
1887.	
Kensington Court Electric Lighting License.	Kensington Court Electric Lighting Company, Limited.
1888.	
Kensington Court Electric Lighting License.	Kensington Court Electric Lighting Company, Limited.
Liverpool Electric Lighting License.	Liverpool Electric Supply Company, Limited.
St. James's Electric Lighting License.	St. James's and Pall Mall Electric Light Company, Limited
1889.	
Kensington Electric Lighting License.	Kensington Court Electric Lighting Company, Limited.
1890.	
Newcastle and District Electric Lighting Company's License.	Newcastle and District Electric Lighting Company, Limited.
Northampton Electric Lighting License.	Northampton Electric Light and Power Company, Limited.

HOLDEN, DRAKE AND GORHAM'S NEW ELECTRICAL RECORDING INSTRUMENTS.

For central lighting and power stations, and all other industries where the electric current is generated on anything like a large scale, recording instruments are gradually becoming a necessity. For municipal authorities on whom devolves the duty of checking the pressure on the Supply Company's mains, such instruments are invaluable. Unfortunately, however, those produced hitherto have not been sufficiently accurate in their indications for the full value of their records to be appreciated, as owing to hysteresis, frictional effects, &c., they have not compared favourably with even the indicating instruments in everyday use. The instruments which Messrs. Drake & Gorham have now brought before the public, are free from

these and other defects of design which would cause their readings to differ from the indication of standards with which they might be compared.

The series of instruments we are about to describe includes the following:—1. Recording ammeter, hot strip principle for either direct or alternating currents, with continuous record. 2. Recording voltmeter. Electro-magnetic with moving coil, open reading for direct currents with intermittent record. 3. Recording ammeter, dead beat, electro-magnetic for direct currents, with continuous or intermittent records. 4. Recording voltmeter, dead beat, electro-magnetic for direct currents, with continuous or intermittent record. 5. Recording ammeter, frictionless, dead beat, with photographic continuous record for direct currents. 6. Recording voltmeter, frictionless, dead beat, with photographic continuous record for direct currents. 7. Combined recording ammeter and voltmeter, dead beat, frictionless, with intermittent photographic record for direct currents. 8. Recording ammeter, frictionless, dead beat, with photographic record for alternating currents. 9. Recording voltmeter, frictionless, dead beat, with photographic record for alternating currents.

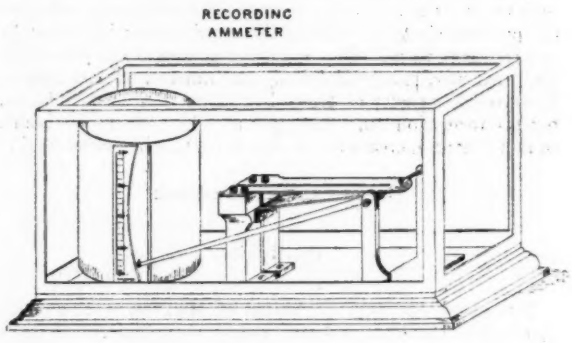


FIG. 1.

I. The hot strip recording ammeter, for either direct or alternating currents, is illustrated in fig. 1, and the principle employed in the working portion is clearly shown in the diagram of fig. 2.

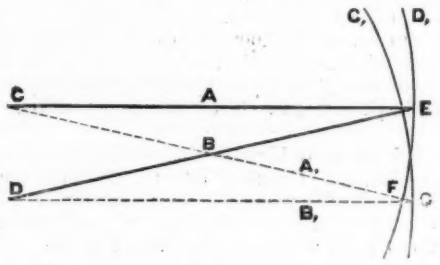


FIG. 2.

Here we have two metal strips, A and B, as shown, of the same length, section, and material. These strips are fastened together by rivets, or otherwise secured at the point, E, and also rigidly secured at C and D, If not fastened together at E, they might be supposed to be capable of turning about the points, C and D, describing the arcs, C_1 and D_1, respectively. But, as we have seen, the strips are rigidly connected at E, and, therefore, if only the upper strip, A, is caused to extend by a rise of temperature in it, produced by the passage of the current, the position which the system of strips will be forced to take up will be one in which the equilibrium is obtained, and this position will manifestly depend on the actual amount of extension of the top strip. For instance, suppose that the amount of extension of the top strip, A, is equal to the length of the line, F, G, then the dotted line, C, G, D, will represent the position of the system when the strip, A, has extended by that amount; and, moreover, it is obvious that this position will be the only one in which equilibrium is produced by a certain definite current in the strip, A, it may, therefore, be said that the position is dependent upon a certain current. It will be understood that a rise of temperature in both strips simultaneously, such as would be produced by atmospheric causes, will not affect the system at all, since each strip will lengthen to the same extent independently, and there will be no turning movement whatever. The record is made on a piece of corrugated paper attached to a vertical drum revolved by clockwork (at a rate which is regulated to suit requirements), by means of a pen containing aniline ink, giving a continuous record. The pen is attached by an aluminium arm to an arbor which is turned through a greater or less angle according to the amount of expansion of the strip. A fixed scale close to the pen enables the amount of current passing at any moment to be read by the eye. This instrument is suitable for either alternating or direct current circuits, it has no errors, and takes little power; on the other hand, owing to the rigidity of the system of metal strips, it is free from the errors which arise from the friction of the pen upon the paper, and form a source of inaccuracy in most of the recording instruments employed at the present time. The width of the paper strip may be from 3 inches to 6 inches, according to whether a very open scale is required or not.

II. Recording voltmeter with moving coil, for direct currents.—The feature of this instrument is its extremely open reading, which, combined with its frictionless action, owing to the intermittent record which it is caused to make by means of an accessory electro-magnet, renders it extremely valuable for checking small variations of potential. The electrical portion of the apparatus consists of a coil, mounted on an arbor, working in jewelled mercurial bearings, and moving in an extremely powerful magnetic field. The pen is intermittently pressed against the paper by means of an accessory electro-magnet in the base of the instrument, worked by means of a main current, or by a single separate cell if desired; the contacts controlling this movement are carried by the clockwork in the drum.

III. Dead beat recording ammeter for direct currents.—The electrical portion of this instrument is a modification of the well-known dead beat ammeter sold by Messrs. Drake & Gorham; the recording portion can be fitted for continuous or intermittent records, the latter system avoiding the friction on the paper entirely. It is similar in external appearance to fig. 3.

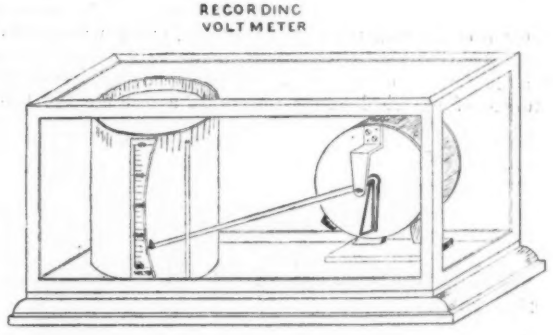


FIG. 3.

IV. Dead beat recording voltmeter for direct currents.—This instrument (fig. 3), differs only from the above in the proportion of the various parts and in the winding; it is remarkably free from hysteresis errors, and is probably more accurate than any recording instrument in use at the present time, though not so accurate as the photographic instruments which we describe below.

V. Ammeter photographic record for direct currents.—This instrument, and those following it, are externally all of the same appearance and size, differing only in their internal details. They are about 4 feet long and 18 inches wide, and are arranged as shown in fig. 4.

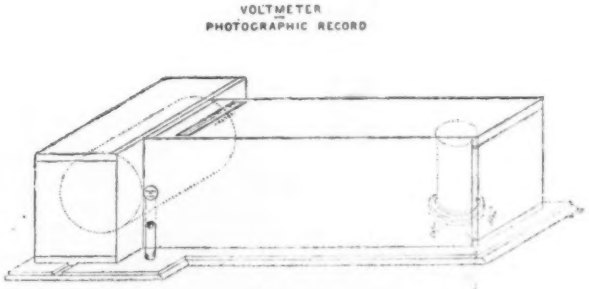


FIG. 4.

The revolving clock, covered with sensitised paper, is contained in a removable box on the left; this box can be removed to the dark room, after closing the shutter, for the paper to be changed and the record developed. The source of light employed may be gas or electric, the beam impinges on the mirror of a Holden D'Arsonval dead-beat galvanometer, and is therefrom reflected to the surface of the drum; a small portion of the beam is, however, directed upwards, and forms a visual pointer on a ground glass scale at the top of the box. The accuracy and convenience of this instrument cannot be surpassed; it is not affected by vibration, the presence of magnets, or any of the usual causes which so disturb the working of most instruments. The process of changing and developing the paper is a simple one; and, lastly, the power taken by this and the succeeding instruments does not exceed one watt.

VI. Voltmeter photographic record for direct currents.—Is similar to the above, differing only in its winding and arrangement, which makes it suitable for measuring voltage.

VII. Combined ammeter and voltmeter photographic record for direct currents.—Is a combination of the two previous instruments, and is constructed in two forms, in the first of which only one galvanometer is employed, which is used to measure the voltage and current alternately by means of a changing switch actuated by the clock, and in the second two separate galvanometers are used, giving two continuous records, which differ from each other by the form of the line made, or by the record being on a different part of the paper.

VIII. Ammeter for alternating currents. Photographic record.—Contains a modification of the above-mentioned galvanometer

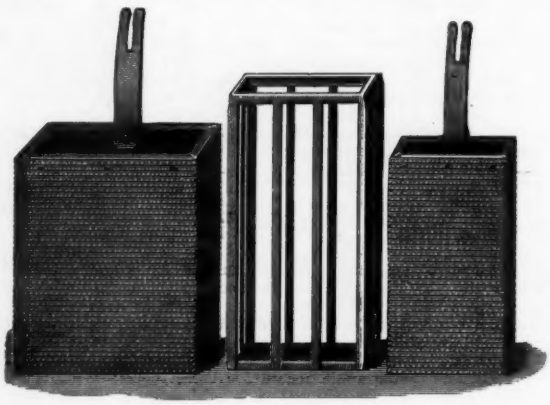
whereby without sacrificing its dead beat and other qualities, alternating currents are measured. There is no error in the instrument due to the frequency of the alternations, and in this respect it is on a par with the first instrument described. The indications are the values of the square root of the mean square of the current passing.

IX. Is a similar instrument to No. 8, but is arranged to measure the voltage instead of the current.

These instruments are being placed on the market by Messrs. Drake & Gorham, who hold patents for several essential points in recording instruments. These particular patterns are the design of Capt. Holden, R.A., who is associated with Messrs. Drake & Gorham in the matter.

THE ELIESON NEW ACCUMULATOR.

In the accompanying drawing we illustrate a new form of accumulator invented by Mr. C. P. Elieson. This accumulator is entirely on the Planté principle, and it will easily be perceived that although it is only composed of two electrodes, a large amount of surface is, nevertheless, provided for the storage of electrical energy; figs. 1, 2 and 3 are the three



FIGS. 1, 2, 3.

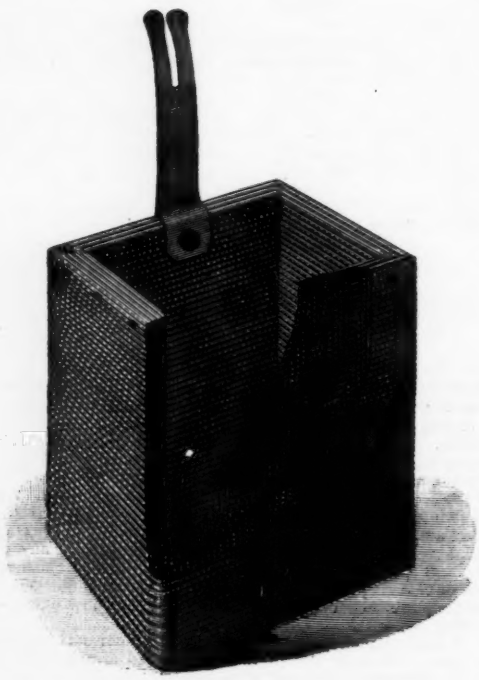


FIG. 4

parts composing such an element; fig. 1 being the negative electrode, fig. 2 the separator, and fig. 3 the positive electrode; the positive electrode is inserted in the skeleton box, fig. 2, the whole is then placed into the negative electrode; a hard rubber box is provided with a rim extending one inch from the bottom of the box, upon which rim the negative electrode rests so as to prevent any possible short-circuiting from the agglomeration of oxide dropping at the bottom. Fig. 4 gives a view of one electrode, where a portion is removed in order to show the internal construction, which is built up of a series of corrugated and perforated envelopes of thin lead. Each of these envelopes are built up on top of each other, and each corrugation is so arranged as to run across or at an angle with the corrugation of the next envelope; in practice, nine of such envelopes compose one electrode. The positive electrode, $5 \times 3\frac{1}{4} \times 8$ inches, possesses 4,000 square inches of exposed surface, the negative electrode measures $6\frac{1}{2} \times 4\frac{1}{2} \times 8$ inches. The lugs which are on each electrode run right to the bottom and are burnt through and through in order to secure a perfect metallic connection with each envelope. The weight of the two electrodes is $12\frac{1}{2}$ lbs., or 23 lbs. including box and electrolyte. It is claimed that such an accumulator requires very little attention, and that the positive electrode will hardly require renewing after 12 months' hard work. The formation process is carried out in the usual way, partly chemically and finished off electrically. The storage capacity of this cell is about 100 ampère hours, but the formation can be stopped at 60 or 80 ampère hours, as it will soon increase in its capacity while in actual work.

NOTES.

Proposed Electric Lighting of Buxton.—At a recent meeting of the Buxton Local Board, a discussion took place regarding the adoption of the electric light. It was agreed that all the necessary information should be obtained within the next fortnight.

Electric Lighting at Whitehaven.—At Whitehaven, on Tuesday, a Local Government Board enquiry was held in reference to the application of the Town and Harbour Trustees to borrow £14,000 for electric lighting purposes. In support of the application, evidence was given that the town would save £150 a year by having electricity for public lighting in place of gas. There was no opposition.

The Telephone in Kent.—Since the merging of the South-Eastern Telephone Company into the National Company's system, considerable progress has been marked in telephonic work throughout Kent, and the *Dover Standard* records a very important change which is being effected in the wires. Six independent gangs of men are now engaged upon the main trunk wires, in order to set up complete metallic circuits, which are arranged in a manner similar to the Paris telephone wires, to prevent induction.

Propagation of Magnetism.—The interesting question of whether or no there be a time rate of propagation of magnetism along a bar when a magneto-motive force is applied at one end, has been the subject of several investigations lately, notably by Mr. Trouton and Mr. Trowbridge. Dr. Julius (in a letter to *Nature*) remarks on some possible errors in these experiments, and comes to the conclusion that all methods used up to the present cannot be considered suitable. Dr. Julius's own result will be awaited with interest.

The Price of Platinum.—It is reported that the recent scare as to the scarcity of platinum was got up for a purpose, and that the increase in price was due to a combination between the English handlers of the ore and a broker in St. Petersburg, who together controlled the production, and got up a "corner" in this article. The increase in price has, however, provoked competition, and several new mines have now been opened, which have increased the production considerably. There are now, says *Industries*, at least 40 mines at work along one river, but the plant employed is of a very primitive character. Some of the mine owners have now introduced steam power, but at present the sand ore is not purified at the works, but sent to an establishment in Germany, where it is prepared for the market. The yield of crude platinum for the year 1891 from the Ural provinces exceeds 9,000 lbs., or 50 per cent. more than the returns for the previous year.

Electric Lighting at Middlesbrough.—The Electric Lighting Committee of the Middlesbrough Corporation have appointed a sub-committee to prepare a report on the present position of electric lighting and the powers of corporations in reply thereto for submission to the council.

Inspection of Cable Stations.—Sir John Pender's party, arrived at Cadiz on Monday last. The party visited the caravel *Santa Maria*, lying in the roadstead, and were entertained at a banquet by Senor Coneas. Later in the day the party visited Jerez. The *Mirror* sailed on Tuesday for Lisbon, whence she will proceed on a cruise to the Northern Spanish ports.

Siemens and Halske in America.—Regarding our several notes on this matter, it seems clear that Messrs. Siemens and Halske are already reaping benefit from their venture in opening an establishment in Chicago. They have secured the contract for a large installation in the premises of the Pabst Brewing Company at Milwaukee, Wis. The plant will comprise three of Messrs. Siemens and Halske's direct-coupled dynamos, two of 250 H.P. each, and one of 90 H.P.

A Bicyclist Lamp Trimmer.—The New York *Electrical Engineer* illustrates a bicyclist lamp trimmer standing beside his bicycle all ready to begin work. In all there are about 65 lamps to be trimmed on two circuits together about 16 miles, the two lamps furthest from each other being about 2¼ miles apart. On a pleasant day it takes about eight hours to trim the lamps, and after the lamps are started, the trimmer goes over the circuit once more to make sure that all the lamps are burning properly, occupying about 1¼ hours in the operation. The bicycle has proved quite a success in Concord, and saves a large amount of time and labour, and could well be applied to other cities.

Governing Water Wheels.—A writer in our American contemporary, *The Electrical Engineer*, suggests a rather novel mode of regulating the speed of water wheels and turbines for electrical purposes. Water engines are now used so extensively in America, and are becoming so much more generally employed in this country, that the attention of electrical engineers has been called to the peculiar difficulties in properly regulating the speed of these engines. The writer in the American paper suggests, somewhat enquiringly, the use of series wound dynamos as electrical brakes. These dynamos are to be designed to "build" at a slightly higher speed than that at which they would be driven by the normal speed of the engine, so that before any dangerous rise in speed occurred the machines would "build" and absorb the surplus power. That this method would work, there can be no doubt; but that it would regulate within a small fluctuation of speed, or that it would be a cheap method of regulation, must be denied. The cost of a series machine, together with the oil bath into which it is to be placed, sufficiently large to take all the surplus power of a lightly loaded engine, would alone be prohibitive. It must be confessed that our trans-Atlantic cousins show a much more decided preference for surplus power than we do. In another column this subject is more fully discussed, and in a later section of the series on "Water Power," it will be seen that surplus power is not more easy to deal with than is a good governor. It is a more economical method of procedure to prevent the surplus power being developed in one's engine, rather than to have to smother it up after it has been developed. Surplus power in large quantities would be a troublesome factor in a generating station; but, where it must be got rid of, there is no more reliable nor steadier method than by means of resistance frames. In governing water wheels it is probably best to follow the recognised practice with steam and gas engines. Water, handled in the proper manner, is really a less difficult working substance to deal with and to control, than steam or gas; and, when the peculiarities of each have been thoroughly studied it is fairly easy to design a governor which shall most satisfactorily suit the requirements of each case.

Fountains and Electric Light.—The Warminster Local Board decided a few days ago to erect a fountain in the Market Place, and have an electric arc lamp fitted on top.

Electric Lighting of St. Helens Town Hall.—At the monthly meeting of the St. Helens Parks and Markets Committee, the matter of the penalty of £104 incurred by Messrs. Andrews & Co., of London, on account of their not completing the electric lighting of the Town Hall within the time specified, came up. Messrs. Andrews hoped the item would not be seriously pressed, as they had sustained a net loss of £94, irrespective of this penalty. The committee felt that the circumstances warranted some penalty, and the matter was left in the hands of the chairman and the Town Clerk.

Resuscitation of Old Ideas.—In a recent issue of *Industries*, under this heading, are some remarks regarding the Sprengel mercury pump. Prof. F. J. Smith, says our contemporary, has re-invented some old mercury elevators for mercury pumps, involving the inverted Sprengel. The inverted Sprengel was known 10 years ago, and was described in a technical contemporary in 1887. "Prof. Smith, however, described a very convenient arrangement, suitable for laboratory work, the compressed air being provided by a water injector. It would be as well for those who design laboratory pumps to look up what has been done already by lamp makers. Every now and then an account of some obsolete arrangement appears in the so-called purely scientific journals."

Magnetic Viscosity.—At the British Association meeting this year, Dr. Hopkinson referred to some experiments on this subject made at King's College. The full account of these experiments has recently been made public. The method adopted is one that has been used in some experiments made in America, and consists in plotting the curves of variation of magnetising current and P.D. on the coil of the ring undergoing magnetisation. From these it is easy to get the curve connecting B and H. In this case the requisite data were got by the usual method of a rotating contact maker. Dr. Hopkinson finds (like Prof. Ewing) that the form of the magnetisation curve is practically the same as it is under ordinary slow cyclic forces, and that the magnetic viscosity has no effect (in the case of such fine wires as the experiment dealt with) up to a periodicity of 125.

Blackpool Electric Tramway Company.—An extraordinary general meeting of the Blackpool Electric Tramway Company was held at Blackpool on Saturday afternoon to consider the advisability of winding up the company. It will doubtless be remembered that about three weeks ago the Blackpool Corporation took over the management of the electric trams, the directors of the tramway company having accepted an offer of £15,750 for the whole of the plant and stock. Mr. J. Horsfall presided, and there was a good attendance. The Chairman briefly proposed that the company should be voluntarily wound up, Mr. Thomas Bottomley seconding. After a short discussion the resolution was adopted unanimously. Upon a vote of thanks being moved to the Chairman, a noisy scene occurred. Mr. J. Wheway, after supporting the vote, said that the Blackpool Corporation had not given that favourable consideration to the company which was deserved. That tramway had been one of the greatest means of bringing people to Blackpool, and the bargain which had been struck reflected very dishonourably upon the Corporation. A scene of confusion followed, during which the Mayor of Blackpool rose and called upon Mr. Wheway to withdraw his last remark. He refused, and was proceeding to remark upon a strong body of men having taken advantage of a weak body, when there was further interruption and further objection from the Mayor of Blackpool. After the noise had subsided, Mr. Wheway added that he did not honour the men who had taken away his property and not given him that to which he was entitled. The Mayor of Blackpool again asked Mr. Wheway to withdraw his remarks, but met with a prompt refusal. The vote of thanks was then carried, and the proceedings terminated.

Accrington and Electric Lighting.—The Legal and Parliamentary Committee of the Accrington Corporation have instructed Mr. Shoolbred, electrical engineer, of London, to prepare plans and estimates for an installation of the electric light, at a cost of £10,000. A central site has been purchased for the engine house and generators.

Corrections. — In the article, "Generalisation of Mercator's Projection Performed by Aid of Electrical Instruments," by Lord Kelvin, P.R.S., which we published in our issue of September 23rd :—In last sentence of fourth paragraph, for "three" read "two." For corrections in section 3, and in last paragraph but one, see article, "To Draw a Mercator Chart, &c.," in the present issue.

Obituary.—We regret to announce the death of Mr. John A. Chambers, of Bradford, which occurred last week. Mr. Chambers was the manager of the Yorkshire District of the National Telephone Company, Limited, and had been in bad health for some time. He was a son of Mr. Joseph C. Chambers, of the Postal Telegraph Engineering Department, Leeds.

Electric Lighting in Leeds.—The Yorkshire House-to-House Electricity Company has commenced operations in Leeds. The laying of the cast-iron pipes into which the mains will be drawn is being vigorously carried out in the main streets of the town, and at the central station considerable progress has already been made. Some of the boilers are already in position, and the erection of the chimney shafts is in progress. It is hoped that the company will be in a position to supply light considerably before Christmas.

Dublin Electric Lighting.—Last Friday the Dublin Central Electric Lighting Station was formally taken over from the contractors by the Corporation, and the streets were lighted for the first time by the Corporation. All the official tests have been completed, and customers will now be supplied with light as fast as the connections can be made. During last week the lighting of the streets was said to be remarkably good, whilst the arrangements for the supply of current for house-lighting purposes is perfect in every way. Only one or two small items now remain to be completed, and Messrs. Hammond & Co., who have constructed the station for the contractors, the Electrical Engineering Company of Ireland, have every reason to be satisfied with the favourable result of their work.

Another Electrical Society.—Our cousins over the water have taken a step which appears to us commendable. They have formed an American Electro-Therapeutical Association, having for its object the "cultivation and promotion of knowledge in whatever relates to the application of electricity in medicine and surgery." It numbers among its fellows, we are told, some of the foremost members of the profession (we presume the medical profession), and is to hold its first annual meeting next month. This sounds well, and gives promise of good work, but we venture to hope that the association contains a sprinkling of practical electricians to assist their medical confrères over some of the physical difficulties which, unfortunately, so often prove stumbling blocks, and not infrequently cause ludicrous blunders when medical men alone meet to consider the applications of electricity to medicine and surgery. We cannot agree with those who regard all that relates to electro-therapeutics as matter for the attention of medical men alone. An esteemed contemporary, in a recent leader, while admitting that the progress in this branch of electrical science has been slow, and in many respects unsatisfactory, came to the very lame conclusion that nothing should be done outside the very exclusive medical circles, and that electricians ought to sit calmly by till some time in the next century, when possibly the medical profession might show more activity on the subject. It might as well hold that electrical engineers should never discuss the applications of electricity to mechanics. Light, more light, is what is wanted to improve the present effete condition of electro-therapeutics, and this can only be given to it by a free ventilation of its problems and difficulties, and open discussion thereon by all who can throw any light upon them, be they lectricians, medical men, or any other body of scientists.

Electric Tramcars in the Midlands.—In less than three weeks the new electric tramcars will be at work on the Wednesbury and Bloxwich, and Darlaston and Walsall sections of the South Staffordshire Tramways Company. One of the cars has been delivered to the Darlaston depôt. From platform to platform it is 22 feet long, and will accommodate 40 passengers.

Coast Communication.—It is said that the statement that the Royal Commissioners to enquire into the feasibility of connecting lightships with the shore had advised that the East Goodwin Lightship should be connected by telegraph wire with Dover, is premature. The Commission holds its next meetings on the 18th, 19th, and 20th of next month, when the report of the recent visit paid to the different lightships will be considered, and evidence will be taken from coastguard officers and masters of lightships.

The Electro-Harmonic Society.—This evening the enjoyable Concerts of the Society will be resumed, with a programme showing no falling off from the high standard of musical excellence which has always characterised the selections. The artistes engaged are all established favourites, and members will welcome the re-appearance of Mr. Arthur Thompson amongst them. The 1892-3 season bids fair, even at this early date, to be highly successful, for already we hear of nearly 20 new applications for membership.

Heckmondwike Electric Lighting.—At a recent meeting of the Heckmondwike ratepayers, the adoption of the electric light was unanimously agreed to, but since then the Local Board have met and discussed the matter very fully. They ultimately constructed a fresh Electric Lighting Committee to go more closely into the question. The Heckmondwike provisional order expires in nine months, so the sooner the matter is settled the better.

Maidstone Electric Lighting.—The Maidstone Local Board have adopted the following recommendation of the Lighting Committee :—"That Mr. W. C. Hawtayne be engaged by your authority to prepare the necessary plans, estimates and specification, and carry out the entire scheme of lighting the borough with electricity ; that Mr. Hawtayne reside in Maidstone during his engagement ; that he be permanently engaged to manage and start the lighting, and required to act as residential engineer in charge of the works for a period of at least 12 months after their completion ; and that during his engagement Mr. Hawtayne be paid a salary of £300 per annum.

Chatham and Electric Lighting. — The Mayor of Chatham, who is doing his level best to municipalise the undertakings of the Chatham electric lighting companies, has prepared a report on the subject. If the corporation undertakes the business, it will be in a position to appropriate for the relief of local rates, on the expenditure of £30,000, the sum of £1,500. By expending an additional sum of £10,000, and so bringing the capital expenditure up to £40,000, the capacity of the Chatham station could be doubled. This would also have the effect of reducing the cost of production, whilst giving a profit of £2,000 per annum.

Penywern House Military and Engineering College. —The prospectus of the classes held at the above college (Principal, Mr. G. W. de Tunzelmann, B.Sc., &c., &c.), is before us. Special courses of instruction are given in electrical engineering, including the theory and practice of electrical testing, and in machine drawing and design. These lectures are attended by engineers and others who have sufficient knowledge to profit by them independently of the complete course of instruction. The results for the year 1892 are as follows :—Number presented for examination for admission to Central Institution, 22, out of which 17 were admitted ; number presented for Cooper's Hill College, two, both of whom were admitted. For the session 1891-92 at the Central Institution, Mr. Harris was first of the first year students in the electrical engineering department.

"Electricity" in Monthly Parts.—Messrs. Cassell and Company, Limited, are now bringing out a new and revised edition of "Electricity in the Service of Man," in monthly parts. The original work, which has been reviewed in our columns, is a popular and practical treatise on the applications of electricity in modern life, from the German of Dr. Ritter von Urbanitzky. It was edited, with copious additions, by R. Wormell, D.Sc., M.A., and is now revised by R. Mullineux Walmsley, D.Sc.(Lond.), F.R.S.E., professor of Applied Physics and Electrical Engineering in the Heriot-Watt College, Edinburgh. Part 1 is ready, price 6d., and the work will be completed in about 14 parts. We congratulate the publishers on their enterprise, for the signs of the times clearly indicate that works of the kind will have an extensive sale.

City and Guilds of London Institute.—We have been requested to announce that all available places in the electrical laboratories of the Finsbury Technical College are already filled for Monday and Wednesday evenings until Christmas. Applicants for attendance at the lectures only can be admitted; but there are still some vacancies in the overflow class in the laboratories on Tuesday nights. Evening lectures at the Technical College will be resumed on October 3rd. In the advanced course on Mondays, Prof. Thompson will lecture on dynamos and motors; the introductory lecture on October 3rd being on magnetic fields. The Wednesday night lectures will be on magnetism and on instruments, till Christmas. Short special courses—always a feature of the work at Finsbury—are numerous in the coming session. First, Mr. G. H. Robertson will give five lectures on accumulators and their chemistry, commencing Thursday, October 6th. On October 20th, Prof. Perry, F.R.S., will begin a course of four lectures on oil and gas engines, and some drawing-office lessons on the same subject by Mr. R. Johnston, begin November 7th. On October 22nd, Mr. Clinton begins four lectures on vector methods of calculation. After Christmas, Prof. Silvanus Thompson, F.R.S., will deal with central stations, and Mr. Rousseau will hold a course of practical lessons in the electroplating laboratory. Prof. Perry, who has for several sessions given special courses on the application of higher mathematics in engineering, has now made these lectures into a regular Friday evening course throughout the winter.

BUSINESS NOTICES, &c.

Drake & Gorham.—Among other work being done by Messrs. Drake & Gorham, we notice that they are carrying out the lighting of the Bank of British North America, 3, Clement's Lane, E.C., the Bank of Egypt, 26, Old Broad Street, the London Assurance Corporation, 7, Royal Exchange, E.C., Lord Knutsford's London residence, at 75, Eaton Square, and also an installation for Mr. James Lowther, M.P., 16, Wilton Crescent, and the Hon. G. Eden, 54, Cadogan Place, and after a great amount of competition this firm have just obtained the contract for the lighting of the Alliance Assurance Offices, at St. James's Street, S.W., together with the chambers above. Messrs. Drake & Gorham have also a large number of country house installations, which are a special branch of their work, amongst which may be mentioned that for Mr. H. H. Tiarks, at Foxbury, Chislehurst, where the power will be derived from two 4 H.P. nominal Otto gas engines, each driving a 5 unit dynamo, which will charge two complete sets of accumulators. Mr. C. Swinfen Eady has also placed in their hands the contract for the lighting of his residence at Oatlands Lodge, Weybridge. In this case the plant will consist of a 3 H.P. nominal Crossley gas engine, with a 3-unit dynamo and a battery of 53 accumulators. They have also in hand a water turbine installation for Mr. J. T. Bridges, at Ewell Court, Surrey, and Chalfont Park for Captain Penton, is now practically completed. Messrs. Drake & Gorham, we hear, are making considerable progress in the neighbourhood of Manchester, where they have obtained both plant and wiring contracts.

Failure of an Electrical Engineer.—At the Brighton Bankruptcy Court, last week, James Collins, electrical engineer, of 80, Church Road, Hove, came up for public examination. The statement of affairs showed gross liabilities £2,528 14s. 7d., of which £2,158 5s. 4d. was expected to rank for dividend; assets, estimated at £949 2s. 6d.; deficiency, £1,209 2s. 10d. Debtor said he commenced business as an electrician in September last, having previously been in a solicitor's office. Mr. Lewin, solicitor, had advanced him money on a reversion, and at the time he started in business, debtor owed him about £600. The money was advanced principally for experiments in electrical engineering, which he had studied for a considerable time previously. Debtor passed his examination.

Electric Lighting of Smithfield Markets.—The electric lighting of the Smithfield Markets, under a somewhat novel scheme, is rapidly approaching completion, and will very soon be formally "opened" by the Lady Mayoress, who will be accompanied by the Lord Mayor. Under the terms of the contract, which is being carried out by Messrs. Julius Sax & Co., on behalf of the Corporation of London, the tenants of the markets will not be put to any expense in the installation of the light upon their premises, and when it is in working order only the same amount as the tenants have been paying for gas will be charged. There will be in all 8,000 lamps of 50 candle-power each. The consulting engineer responsible for the design of the whole thing is Mr. W. H. Massey, M.I.C.E., of Twyford. The electric light will replace gas, which is at present costing £18,000 per annum. Mr. Massey has recommended slow-running vertical engines, coupled directly to a continuous current machine, and we believe this is the first time such an arrangement has been tried on a large scale in England.

Electric Light at Ardrossan Harbour.—This installation is now practically completed, and Ardrossan can claim the distinction of being the first port on the West Coast of Scotland possessing a harbour lit by electricity. There are 17 arc lamps placed at equal distances apart on the north and east side of the new dock, and at the Montgomerie Pier (Caledonian Railway) Station. The electricity is generated in a dynamo placed in the hydraulic engine-room, which is capable of supplying illuminating power to other three lamps should it be found necessary to erect these. The superior lighting will be found of immense advantage in effecting the rapid loading and clearing of vessels during the night. The work has been carried out by Messrs. Maver & Coulson, electrical engineers, Glasgow, and the results of a trial made on Wednesday evening proved most gratifying, and showed the excellence of their work. The engine-room, in which the electricity is generated, is lit by a single lamp. Each lamp has an illuminating power equal to 3,000 candles.

The Electric Light in the West End.—Since our last report several further contracts for electric lighting have been taken in hand in this district, among which we may mention that Messrs. Mather & Platt, of Westminster and Manchester, have secured the contract for the wiring of the Vaudeville Theatre in the Strand.—The Planet Electrical Engineering Company are fitting up an installation at 110, Strand.—Messrs. J. G. Statter & Co., Westminster, are fitting up some new buildings in St. Clement's Inn, near the Law Courts, Strand.—The Planet Electrical Engineering Company are engaged upon the new premises of Messrs. Abbotts, 54, Regent Street.—The same company are also fitting up the premises of Messsrs. Allen, Wright & Co., 217, Piccadilly.—The United University Club in Suffolk Street, S.W., which is at present closed for repairs, is also in course of being fitted for electric lighting, the contract having been secured by Messrs. Mather & Platt.

Tenders Wanted—Telegraph Stores.—Tenders will be received until noon on October 21st by the Postmaster-General for (*a*) supply of red fir telegraph poles, to be delivered in London, King's Lynn, or Sutton Bridge, and at Northumberland Dock (River Tyne), West Hartlepool, Hull, or Grimsby; and (*b*) creosoting the poles with 10 lbs. or 12 lbs. of creosote to the cubic foot as may be directed. The poles to be felled between November 1st and February 28th, 1893, and be delivered during the following summer at the port at which the creosoting is to be performed, but poles felled last winter may also be offered. Butt sections from not less than three poles, to show the quality of timber offered, must precede or accompany the tender of any person who has not already supplied the Postmaster-General with poles. Forms of tender, containing all particulars, may be obtained on application to Mr. C. E. Stuart, controller of stores, Telegraph Street, London, E.C.

Tenders Wanted.—Dundee.—At a meeting of the Dundee authorities on Monday last, instructions were given to the engineers to advertise for tenders for an overhead travelling crane for the engine and dynamo room at the central station.

Tenders Accepted. — Messrs. Crompton & Co., of Chelmsford, have secured the contract for lighting the Liverpool Street, Bishopsgate, and Spitalfields stations with the electric light, for the Great Eastern Railway Company. The amount of the tender is £23,000. Messrs. Davey, Paxman & Co., of Colchester, take £5,900 of this for supplying the engines, &c.

We understand that the contract for the electric light fittings for the new police courts at Nelson, has been placed with Mr. T. Barton, of Blackburn.

Personal.—Mr. Albion T. Snell, since he severed his connection with the General Electric Power and Traction Company, some five months ago, has been practising as a consulting engineer, making a speciality of electrical transmission of power, more particularly with reference to colliery and mining work. This is a field in which he has had many years' practical work, and in order to ensure the highest degree of efficiency in work entrusted to him by colliery proprietors and mining managers, he is consulting with Messrs. Walker & Hardwick, mining and civil engineers, of Sheffield and London. Mr. Snell's offices are at Suffolk House, Laurence Pountney Hill, London, E.C., and North Church Street, Sheffield.

Exhibition.—An exhibition in connection with Tropical Agricultural Engineering and General Manufacturers, under the auspices of an influential local committee, is to be held in Batavia, from May to September, 1893. Notification of a desire to exhibit at this exhibition, which is to be called the Dutch East India Agricultural and Industrial Exhibition, must be sent to Messrs. Henry Hemans & Co., of 35, Queen Victoria Street, E.C. All goods are to be admitted free of duty, and steamship companies will allow 50 per cent. off the usual freight on all goods unsold, and returned to port of shipment.

Electric Lighting Progress in Australia.—A copy of the Sydney *Building and Engineering Journal* to hand by this week's mail, contains an article on the progress of electric lighting, more especially in regard to the streets and houses in the borough of Redfern, adjoining the city of Sydney. Our contemporary also gives as a supplement a plan of the Redfern central electric light station, the complete and efficient plant of which was supplied by the Williamson Electrical and Engineering Company, Limited, of 15, Pitt Street, Sydney. It is said that this work is superior to any of a similar kind ever attempted in New South Wales, and an article referring to it appears in our present issue.

The Electric Light in Holloway.—A recent visit to this quarter of London shows that electric lighting has been largely adopted for the handsome shops in that district, several very large contracts being noticeable. Among the work at present in hand is one by Messrs. Sharp & Kent, of Victoria Street, Westminster, in the large additional premises, just approaching completion, of Messrs. Jones Bros., drapers, &c., in Holloway Road.—Electric lighting work has also recently been completed in the public baths, Hornsey Road.

Electric Lighting at Portsmouth.—At the meeting of the electric lighting committee of the Portsmouth Town Council on Monday evening, the tender of Mr. T. W. Quick, contractor, was accepted for the erection of the electric light station at Portsmouth, the contract price being £8,400. The work is to be pushed forward at once, and it is expected that the foundation stone will be ready to be laid by October 27th.

Smart Work in Electric Lighting.—On the occasion of the recent visit of the Associated Chambers of Commerce to Newport, a powerful arc light was fixed in the tower of the Town Hall, the current being furnished by a dynamo placed in the fireman's yard at the back. The whole of the work was fitted up by Messrs. Sydney F. Walker & Co., of the Cardiff Electrical Works, within 12 hours, and the light worked without a hitch during the week.

Photography.—At the exhibition of the Photographic Society of Great Britain, now open at the gallery of the Society of Painters in Watercolours (5a, Pall Mall, East), there is a most interesting and excellent collection of specimens of the different styles of photography, as well as of pictures produced by the various processes of which photography forms the groundwork.

The Electric Light in South London.—The already large amount of electric lighting work being done in the South London district is being increased by work which is at present being carried out by Messrs. Easton & Anderson, Limited, of Erith and London, in the well known flour mills of Seth Taylor, situate in Waterloo Bridge Road.

Workshop Electric Lighting. — Messrs. Harpers, Limited, of Aberdeen, have placed an order for the electric lighting of their new workshops with The General Electric Power and Traction Company, Limited, of Kentish Town. Two of the new shops to be thus lighted are each equal in size to the Bethnal Green Museum.

Pioneer Telephone Company.—The *London Gazette* contains an announcement to the effect that all creditors of the above company are required, on or before October 25th, to send their names and addresses, and the particulars of their debts or claims, to the liquidators of the company, at 1 & 2, Great Winchester Street, E.C. The names of the liquidators are C. T. Praed and J. Cecil Bull.

The Electric Light at Reading.—The Corn Exchange, which has recently undergone extensive alterations, has been fitted with a complete installation of the electric light. In the large hall arc lamps have been employed, and incandescent lamps used in the corridors.

Plant for Sale.—Messrs. Wheatley Kirk, Price & Goulty have sent us a list of electric lighting and other plant which they are at present offering for sale. The principal items are arc lamps, boilers, engines, dynamos, and arc and incandescent installations.

Private Electric Lighting.—The Duke of St. Albans has entrusted Messrs. Edmundson & Co. with the installation of the electric light in his town house at Dublin.

Removal.—The West End office of the Commercial Cable Company has been removed to 1, Northumberland Avenue.

CITY NOTES.

The Brush Electrical Engineering Company, Limited.

THE third annual report to be presented to the shareholders at the general meeting of the company, to be held at Cannon Street Hotel, London, E.C., on Friday, September 30th, 1892, at 3 p.m., read as follows:—The directors, in submitting the balance-sheet and profit and loss account for the year ended June 30th last, state that the profit and loss account shows a gross profit of £55,757 11s. 3d., inclusive of the amount brought forward from last account. After deducting standing charges, maintenance of buildings, plant, and patents, and interest on debentures and new debenture stock, there remains a balance of £27,660 15s. 8d. The directors recommend that, as in former years, £3,000 be applied to reduction of property, patents, and goodwill accounts, and £800 to reduction of preliminary and other expenses account. An interim dividend at the rate of 6 per cent. per annum upon both preference and ordinary shares, absorbing £11,553 16s. 1d., has been paid for the six months ended December 31st, 1891, and the directors recommend that £11,553 16s. 1d. be applied to the payment of a further dividend, making 6 per cent. per annum upon both classes of shares; the balance of £753 3s. 6d. being carried forward to next account. With a view to providing additional capital for extensions at the Loughborough works, and to enable the company to deal adequately with contracts on hand for electric lighting and other work in the City of London and elsewhere, the capital account has during the past year been increased by the issue of shares to the amount of £11,223. During the year the £75,000 6 per cent. mortgage debentures of the company have been redeemed by the issue of £125,000 4½ per cent. perpetual debenture stock, of which the major portion was issued to holders of the £75,000 mortgage debentures at the rate of £110 4½ per cent. debenture stock for each £100 6 per cent. mortgage debenture. The amount of this premium has been added to the property, patents, and goodwill account. The capacity of the company's works at Loughborough has been increased during the past year by the erection of additional buildings and plant, and the company is now in a favourable position for undertaking large central station and other contracts. Further additions with a view to the concentration of the company's manufacturing operations at Loughborough are now in progress. The locomotive and rolling stock department continues satisfactory, and important contracts have been carried out during the year. The vertical steam engines manufactured by the company specially for the driving of electrical machinery also continue to grow in favour, and numbers have been supplied to other firms engaged in the electrical industry. Satisfactory advance has been made with the City of London Electric Lighting contract referred to in the last report, and the plant already installed is now regularly supplying public and private electric lighting in a large part of the City of London. The plant so far erected for the City of London Electric Lighting Company represents only a small portion of the total work to be done for that company, and in view of the numerous applications which have been received for light in the City of London, it may fairly be anticipated that the work to be executed during the current year, under this contract, will add very materially to the volume of business. The company has also, during the past year, secured large contracts from municipalities for the equipment of electricity supply stations in several of the leading towns of Great Britain, and the prospects of other local authorities deciding to carry out central station works, and of this company sharing fully in the execution of such orders, are encouraging. The directors deemed it advisable to make a comprehensive exhibit of the company's manufactures at the recent Crystal Palace Electrical Exhibition, and there is every indication that the results will justify the course adopted. The whole of the cost connected therewith has been written off in the profit and loss account, before arriving at the net balance shown. The directors submit, as before, a separate balance-sheet of the company's foreign and colonial branches at Vienna, Temesvar and Australia. The Austrian and Hungarian businesses of the company have made good progress during the past year. Negotiations in connection with a re-arrangement of the company's interests in both businesses are still in progress. The policy of establishing a branch of the company in the Australian colonies is now bearing fruit. Some important contracts and sales have been effected, and others are under negotiation. The company own the Edison patents throughout Australasia; and recent decisions in the New South Wales courts have confirmed these patents as controlling the sole right to the manufacture and supply of incandescence lamps. Mr. E. Garcke has resigned the position of managing director, but retains his seat at the board. Messrs. John S. Raworth and R. Percy Sellon, who formerly held the positions of chief engineer and assistant manager respectively, have been appointed joint managers. Messrs. E. Woods and E. Garcke retire by rotation, and offer themselves for re-election. Messrs. Cooper Brothers & Co., the auditors, offer themselves for re-election.

BALANCE SHEET, June 30th, 1892.

Dr.	£	s.	d.
To Authorised capital	750,000	0	0
„ Capital issued, viz.:— 75,000 6 per cent. preference shares of £2 each, £150,000; 78,383 ordinary shares of £3 each, £235,149	385,149	0	0
„ 4½ perpetual debenture stock	111,347	0	0
„ Sundry creditors (including £22,365 6 per cent. mortgage debentures, to be paid off on December 1st, 1892), £59,624 8s. 8d., and to bills payable, £19,055 14s. 4d.	78,680	3	0
„ Reserve account, as per last account, less £1,195 15s. 5d. applied during the year, £3,080 0s. 9d.; and received on account of contracts in course of execution, £15,100	18,180	0	9
„ Balance of profit and loss account, £27,660 15s. 8d.; less interim dividend paid on preference and ordinary shares, £11,553 16s. 1d.	16,106	19	7
NOTE—Contingent liability in respect of uncalled capital on shares in other companies on guarantee and on bills receivable discounted... ... £12,701 8 7			
	£609,463	3	4

Cr.	£	s.	d.
By property, patents and goodwill, as per last balance-sheet	266,270	19	10
„ Additions to buildings, £964 2s. 1d.; ditto to plant, £1,761 3s. 7d.; expenditure on new inventions, £558 9s. 3d.; redemption of debentures, £7,500; less written off last year and amortisation of leases, £3,733 6s. 10d. ...	7,050	8	1
„ Goods in hand in process of manufacture and materials at London, Loughborough and other places	77,990	18	7
„ Debtors— Sundry accounts (after provision for doubtful debts), £105,706 1s. 3d.; Bills receivable, £465 0s. 9d....	106,171	2	0
„ Cash at bankers, in hand, and at call	25,900	4	10
„ Shares and debentures in other companies ...	39,399	0	0
„ Provisional orders account, as per last account, less amount charged to contracts during the year...	500	0	0
„ Preliminary expenses, as per last account, £1,261 15s. 8d.; by expenses of share and debenture issues, £1,743 6s. 7d. = £3,005 2s. 3d.; less written off last year, £630	2,375	2	3
„ Liquidators' balances and suspense accounts ...	1,068	1	9
„ Balance of foreign and colonial branches accounts, being excess of assets over liabilities.	82,737	6	0
	£609,463	3	4

APPROPRIATION ACCOUNT.

Dr.	£	s.	d.
To Further dividend on preference and ordinary shares at the rate of 6 per cent. per annum ...	11,553	16	1
„ Reduction of property account	3,000	0	0
„ Reduction of preliminary and other expenses ...	800	0	0
„ Balance carried over...	753	3	6
	£16,106	19	7

Cr.	£	s.	d.
By Balance	16,106	19	7
	£16,106	19	7

PROFIT AND LOSS ACCOUNT for the year ended June 30th, 1892.

Dr.	£	s.	d.
To Directors' fees, £1,875; auditors' fees, £52 10s.; salaries, £7,871 19s. 5d.; staff bonuses, £1,910 6s. 11d.; law charges, £438 13s. 2d.; insurance, £762 15s. 2d.; postage, stationery and printing, £1,091 19s. 11d.; travelling, carriage and freight, £667 8s. 5d.; advertising, agency and sundries (including £2,172 7s. 11d. cost of Crystal Palace Exhibition), £5,385 6s. 7d. ...	20,055	19	7
„ Maintenance of plant and buildings	2,501	15	0
„ Ditto of patents	396	10	11
„ Interest on debentures and debenture stock to June 30th, 1892	5,142	10	1
„ Balance, being net profit	27,660	15	8
	£55,757	11	3

Cr.	£	s.	d.
By balance from last account	306	11	5
„ gross profit, including net profit of Foreign and Colonial branches	55,450	19	10
	£55,757	11	3

BALANCE SHEET OF THE FOREIGN AND COLONIAL BRANCHES.

Being the Balances of the following Accounts:—Vienna (made up to December 31st, 1891), Temesvar (made up to June 30th, 1892), Australia (made up to April 30th, 1892).

Dr.	£	s.	d.
To Open accounts and bills payable, £63,234 14s. 3d.; unpaid balance of purchase price of land secured by mortgage, £7,250	70,484	14	3
„ Balance of assets over liabilities transferred to general balance sheet	82,737	6	0
	£153,222	0	3

Cr.	£	s.	d.
For Freehold and leasehold lands, buildings, plant, tools, fixtures, &c., at Vienna, Temesvar, and in Australia	62,305	19	5
„ Goods in hand, in process of manufacture and materials	44,213	4	1
By Sundry accounts (after provision for doubtful debts) and bills receivable, including estimated profit to June 30th, 1892	42,211	14	2
„ Cash at bankers and in hand	2,815	18	7
„ Shares in other companies	20	0	0
„ Australian suspense items	1,655	4	0
	£153,222	0	3

City of London Electric Lighting Company, Limited.

THE City of London Electric Lighting Company, Limited, offers for subscription at par 20,000 cumulative 6 per cent. preference shares of £10 each. The company was formed in 1891 to supply electricity throughout the City of London. The share capital is £800,000, divided into 40,000 ordinary shares and 40,000 preference shares of £10 each. The whole of the ordinary shares have been issued and paid up, and the present issue is of the first half of the authorised 40,000 preference shares. It is intended to issue the remaining 20,000 towards the middle of 1893 at a premium. Up to the present time more than 320 miles of ways have been laid under the streets, and more than 90 miles of cable have been drawn in; 360 arc lamps of 2,000 nominal candle-power each have been erected and put to work in the main thoroughfares under contract with the Commissioners of Sewers. Progress has also been made with the supply of current to private consumers. Signed applications for current for over 40,000 8-candle-power lights have already been received, of which about 16,000 are now being supplied. The work of erecting the main buildings at the company's generating stations is being pushed on day and night, and it is hoped that the first portion will be ready for the erection of machinery early in October. It is estimated that the additional capital now asked for will place the company in a position to supply current to about 150,000 private lights. The list of subscriptions opened on Wednesday, 28th inst., and closes to-day (30th inst.), at 4 o'clock for both town and country. The preference shares are to bear interest at the rate of 6 per cent. per annum. Further particulars will be found in our advertisement pages.

Cambridge Electric Lighting Company.

THE first meeting of the Cambridge Electric Lighting Company has been held at the registered offices of the company, No. 2, Sidney Street, Cambridge.

The Chairman (Mr. Finch) presided.

The MANAGING DIRECTOR (Hon. C. A. Parsons) reported upon the progress of the works, &c., to the effect that the buildings were nearly completed; two boilers, which weighed about 27 tons each, had been safely landed, and were being built into their places. Much difficulty had been met with in the foundation of the chimney, which had to be sunk to the depth of 27 feet, but all difficulties had been overcome, and no accident had occurred; 1¾ miles of cast-iron pipes had been laid in the streets, and 4,500 incandescent lamps had been signed for. The wiring of the colleges and many of the shops is being actively carried out by a good staff of experienced workmen. The engines, condensers, &c., are well forward, and about ready for delivery. It is expected that a portion of the plant will be in operation about the middle of October, and everything is being energetically pushed forward, under the supervision of Mr. D. Hunter, the superintending engineer.

Anglo-American Telegraph Company, Limited.—At a meeting of the board of directors of the Anglo-American Telegraph Company, Limited, held last Friday, it was resolved to declare an interim dividend for the quarter ending September 30th, 1892, of 12s. 6d. per cent. on the ordinary stock and 25s. per cent. on the preferred stock, less income tax, payable on November 1st to the stockholders registered on the books of the company on September 30th, 1892.

City of London Electric Lighting Company, Limited.—Application has been made to the Stock Exchange Committee to allow the following to be quoted in the official list:—City of London Electric Light Company, Limited: Further issue of 9,848 ordinary shares, Nos. 70,153 to 80,000.

Electric Construction Corporation.—Mr. J. S. Balfour, M.P., has resigned his seat at the board of the Electric Construction Corporation.

Eastern Telegraph Company, Limited.—An interim distribution of 2s. 6d. per share is announced for the quarter ended June 30th, payable on October 14th.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 23rd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, amounted to £4,009.

The City and South London Railway Company. The receipts for the week ending September 25th, 1892, amounted to £768; corresponding month, 1891, £708; increase £60; total receipts to date, 1892, £9,971; corresponding period, 1891, £9,126; increase £845.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, September 22nd.	Closing Quotation September 29th.	Business done during week ending September 29th, 1892. Highest.	Lowest.
250,000£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 — 103	100 —103	...	...
1,247,720£	Anglo-American Telegraph, Limited	Stock	48 — 49	48½ — 49½	48½	...
2,876,140£	Do. do. 6 p. c. Preferred	Stock	89 — 90	89½ — 90½	90½	89½
2,876,140£	Do. do. Deferred	Stock	9⅝ — 10⅛	9⅝ — 10⅛	10	9⅞
130,000	Brazilian Submarine Telegraph, Limited	10	11¼ — 11⅜	11 — 11½	11⅜	11 3/16
53,209£	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3⅛ — 3⅜	2⅞ — 3⅛	3 1/16	3
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2 — 2¼	2¼	2⅛
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½ — 3½	2½ — 3½	2⅞	2⅜
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152 ...	10	10⅜ — 11½	10½ — 10⅞	11	10 1/16
$7,716,000	Commercial Cable, Capital Stock	$100	155 —165xd	155 —165	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	⅛ — ⅜	⅛ — ⅜	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½ — 5⅝	5½ — 5⅝	...	...
16,000	Cuba Telegraph, Limited	10	11 — 12	11½ — 12½	12	11⅜
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼ — 3⅜	3¼ — 3⅜xd	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10xd	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜ — 11⅞	11⅜ — 11⅞	11⅞	11⅜
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅞ — 15⅛	14⅞ — 15⅛	15	14⅞
70,000	Do. 6 p. c. Preference	10	15½ — 16	15½ — 16	16	...
200,000£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109	106 —109	...	...
1,200,000£	Do. 4 p. c. Mortgage Debenture Stock	Stock	110 —113	111 —114	112⅜	111
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15⅛ — 15⅜	15⅜	15¼
70,600£	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	...	...
250,200£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	...	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	109 —112	109 —112	110⅜	...
122,400£	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	103½	...
163,700£	Do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	103½	...
300,000£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 —106	103 —106	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	4½ — 5	4¼ — 4⅜	4⅜	4¼
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	⅜ — 7/8	⅜ — 7/8	1 3/8	⅜
82,395	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅜ — 2⅝	2⅜ — 2⅝	2 9/16	2⅜
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1⅜ — 1⅝	1⅜ — 1⅝	1¼	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10¼ — 10½	10¼ — 10½	10 7/16	10¼
180,042	Do. do. 6 p. c. Preference	10	15⅝ — 15⅝	15⅝ — 15⅝	15 9/16	15⅝
150,000	Great Northern Tel. Company of Copenhagen	10	18¼ — 19	18¼ — 19	18⅜	...
210,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	103½	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	5½ — 6½	5½ — 6½	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½ — 10½	9½ — 10½	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½ — 22½	21½ — 22½	22 5/16	22
200,000£	Do. do. 4½ p. c., Deb., 1896	100	104 —106	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	42 — 44	42 — 44	44	42½
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½ — 3½	2½ — 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 7/16 — 3 9/16	3 7/16 — 3 9/16	...	...
10,000	Do. do. fully paid	5	5 1/16 — 5 3/16	5 1/16 — 5 3/16	5⅛	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000£	Do. do. do. 6 p. c. Debentures	100	105 —108	105 —108	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6½ — 7	6½ — 7	6⅝	...
50,000£	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	102 —105	102 —105	...	...
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅝ — 4⅞	4⅝ — 4⅞	4⅞	4⅝
15,000	Do. 6 p. c. Cum., 1st Preference	10	13¾ — 14¼	13⅝ — 14¼	14 3/16	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13¼ — 13⅝	13¼ — 13⅝	13 1/16	13 1/16
726,477£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	110 —112	111 —113	112⅝	111½
48,000£	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	1 — 1½	1 — 1½	1⅝	1½
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	4 — 4½	4 — 4½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	1/16 — 5/16	1/16 — 5/16	...	...
10,802	Reuter's Limited	8	7 — 8	7 — 8	7¾	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7⅞ — 8¼	7⅞ — 8¼	...	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	8 — 8½	8¼	...
3,381	Submarine Cables Trust	Cert.	116 —121	116 —121	118½	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3½ — 4	3½ — 4	3 13/16	3⅞
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	44 — 46	44½	...
150,000£	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	2	1⅞
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½ — 7½	6½ — 7½	...	...
271,400£	Do. do. do. 5 p. c. Debentures	100	100 —103	100 —103	102½	101¼
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3 — 4	3⅜	...
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 —106	102 —106	105	104½
64,242	Western and Brazilian Telegraph, Limited	15	9 — 9½	8⅜ — 9⅛	9	8⅜
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	6¼ — 6⅜	6¼ — 6⅜	6½	6 7/16
33,129	Do. do. do. 5 p. c. Deferred	7½	2⅜ — 3¼	2½ — 3	3	...
184,100£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	...	...
230,100£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	1 — 1½	1 — 1½	1½	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9¼ — 9⅜	9¼ — 9⅜	9⅜	9 7/16
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8 — 9	8 — 9	...	...
80,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	103 —106	103 —106	104½	103½
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	123 —128	123 —128	...	...
171,000£	Do. do. 6 p. c. Sterling Bonds	100	97 —102	97 —102	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6 — 6½	6 — 6½	6 3/16	6⅛

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. BANK RATE OF DISCOUNT.—2 per cent. (April 28th, 1892).

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7½—7⅞.—Electric and General Investment, shares of £5 (£1 paid), 2¾—3⅛.—Founders' shares, 200—225.—Elmore Foreign and Colonial Copper, Founders shares, 6⅜—7½.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2¼—3½.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5—5⅛, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5⅛—5⅜.—Liverpool Electric Supply Shares of £5 (fully paid), 5 1/16—5 3/16.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—⅛.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—⅛.—Do. Debentures, 103—⅛.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ⅛—¼.—£5 Preference (fully paid), 2¼—3.

THE ELECTRIC LIGHTING AT FRANKFORT-ON-MAIN.

[FROM OUR OWN CORRESPONDENT.]

YOU have recently published an extract from the technical opinion of Messrs. W. H. Lindley and Oscar von Miller on the project of the electric lighting of Frankfort-on-Main, which comes to the conclusion that for the erection of electrical works to supply the entire urban territory of Frankfort with electric current, the distant conduction system, with alternating current transformers, is most suitable, and this system is therefore recommended for adoption.

As it was to be expected, this opinion has not remained without contradiction on behalf of the representatives of continuous systems. The Joint Stock Accumulator Company, of Hagen, and the firm Schuckert & Co., of Nurnberg, have criticised and attacked this opinion in communications to Herr Adickes, the chief Burgomaster of Frankfort.

The authors of the opinion have, in turn, replied to these communications in a very comprehensive letter addressed to the Burgomaster. We will briefly summarise the contents of this very interesting reply in its most important and weightiest features.

It was asserted by the opponents that hitherto few alternating current installations had been carried out in comparison with the continuous current installation.

This assertion is refuted by the simple proof that at the time of the Frankfort Exhibition 49 alternating central stations had been erected in European cities alone, a number which has since been considerably increased.

As a reply to the assertion that the alternating current was inferior in value to the continuous current, especially as regards defective motors, the authors of the technical report refer to the results of the Frankfort Exhibition, which refute this assertion, and they further refer to the results of practice, as both in Vienna, in Fiume, and other cities, where alternating current works have been erected, alternating current motors are working with the best results.

It was further alleged that the use of a secondary net for alternating current centrals was as yet untried, and liable to disturb the telephones.

In reply, the reporters above named point out the opposite results of the thorough examination of an alternating-current project for Frankfort made three years ago, in which a secondary net was provided.

The motive which then held good, to obtain from the very outset a systematic secondary net to avoid the introduction of high tension transformers into the houses, to provide large, and hence more economical and substantial transformers, to effect a perfect equalisation of tension, to keep up the supply of current even if a transformer should ever fail, was also, in the opinion of Messrs. Lindley and von Miller, decisive.

The effects which may be produced upon telephones by earth contacts are certainly distributed by the secondary net over a large urban district. But this takes place in the same manner with all continuous current centrals, and in particular with electric tram lines. Safety arrangements may be applied to obviate the disturbances thus occasioned; but, in the case of the alternating current centrals hitherto installed with distributive leads, no especial disturbances have occurred.

In reply to an enquiry on this subject, the company "Electra" (of Amsterdam), which also works with alternating current transformers, state that the distributive net in the Calver Strasse has worked satisfactorily for three years, and that no accident or disturbance to the telephones has ever occurred.

The town engineer Oerth, of Carlsbad, states that both the primary and the secondary cable net have worked perfectly, and given no occasion for disturbance or accident, and that telephone disturbances occurred only a few times in houses in consequence of negligence in carrying out the house installations. The telephone net in Carlsbad, like that in Frankfort, is above ground.

In Luzern, the transformer stations have been connected together for some years, and, according to enquiries made, the arrangement has there proved satisfactory.

The assertion that the total machinery in the project of the experts has been selected too small, and, therefore, disadvantageous, is rebutted as totally groundless, as well as the contention that in the continuous current project elaborated the prices per unit for transformers, and for feeding-leads, have been taken too high.

With reference to the latter assertion, it is pointed out that the prices fixed were founded upon offers made by the most eminent firms, and that the unit prices for the cables in single cases were even lower than those demanded by Schuckert & Co. in their letter to the chief Burgomaster.

The contention of the enemies of the alternating-current system, that by increasing the time of service from 18 to 24 hours the expenses of the installation might have been reduced, is refuted in the reply on the basis of accurate computations.

It is shown that even the economy to be effected in such a case would not suffice to justify the considerable unfavourable conditions of working. In other respects these slight differences of price would not make any change in the choice between the projects.

The two firms above mentioned have further complained that in the project of the experts the time of burning was assumed at 1,200 hours per lamp simultaneously in operation, which they think far too high, whilst with a shorter time of burning an alteration in the figures would be effected more favourable to the continuous current project.

To this it is replied that the calculations are founded on experiments made at gas works. The assertion made by Schuckert & Co. depends upon an error, in as far as it confounds the 34,000 lamps burning simultaneously, mentioned on page 5 of the report, with the 67,000 lamps burning simultaneously of the entire installation.

The 1,200 burning hours of the lamps burning simultaneously would, therefore, as expressly stated in the last section of the report of the experts, correspond with 600 burning hours of the lamps installed, of which, however, according to the assumptions of Messrs. Lindley and Von Miller, at least one-sixth remain unconnected.

"By the foregoing we believe we have proved," say the authors of the technical report, "that the objections raised against our report of June 1st of the current year, are baseless, and that the dispositions proposed by third parties give no reason for modifying our original project to erect the central according to the project A (alternating current)."

Messrs. Lindley and Von Miller had in the meeting of the Commission on the 30th of last month, in view of the attacks subsequently made by competitors, requested for a short postponement of the question of the electric lighting of Frankfort until they had refuted the objections.

Since this has now been done, the question of electric lighting came before the representatives of the city on the 6th of this month.

Herr Sonnemann on behalf of the mixed commission, gave in a report on the erection of the municipal electric work recommending the adoption of the alternating current, and showing that the remarks of the Accumulator Company, of Hagen, and those of Schuckert & Co. had been thoroughly refuted by Messrs. Lindley and Von Miller. The speaker had been officially informed that at the central at Barmen (which works with accumulators) the installation at the end of three years was to be returned as defective, and that a similar central station (with accumulators) at Düsseldorf, for 10,000 glow lamps has required a payment 220,000 marks for the cost of installation, *i.e.*, more than for Frankfort with 21,000 lamps.

Herr Sonnemann remarked further, that he had reluctantly agreed to the new proposals of the Commission, *i.e.*, that continuous current firms should be invited to compete, as he feared delays, and he urged the meeting to secure electric works for Frankfort.

After this discourse, the meeting of representatives resolved as follows:—

1. To concede the erection of a central station for electric lighting and the transmission of power on the municipal plot of ground on the Speicher Strasse.

2. To issue an invitation, primarily, for tenders under the project A (alternating transformer system), as proposed by Messrs. Lindley and Oscar von Miller, but also to accept tenders under the projects B and C.

AUSTRALIAN ELECTRICAL NOTES.

[FROM OUR OWN CORRESPONDENT.]

THE Electric Club, of New South Wales, having held another highly successful smoking concert, has settled down to work again, and at a meeting on August 3rd Mr. J. H. S. Brearley read a very interesting paper on "Alternating Current Motors." The author divided alternating current motors into two main types: (*a*) Those which are modified forms of continuous current machines with special "redressing" apparatus, intended to convert the alternating into a uniformly directed current, and in which the field is approximately constant in strength and direction, such as the Patten and Zipernowski; and (*b*) Those in which the field alternates and the armature may, or may not, be short-circuited, such as the Mordey and Elihu Thomson. The necessity of synchronism to obtain a continuous torque in motors of the first-class was then gone into, and diagrams and lantern slides used illustrating the action of Zipernowski's, Patten's, and Mordey's motors, and their respective advantages and disadvantages discussed; the author stating that, owing to the periodic variations of the redressed current in the field magnet circuit of the Mordey machine, there was a large waste of energy, involving a necessity for lamination, or, as Mr. Swinburne suggested, a heavy winding of copper round the field magnets to prevent the fluctuation in the field strength.

The synchronising closed armature type was briefly discussed, and then the main issue, rotary field motors, was taken up; the author, notwithstanding the controversy which has been going on as to priority of claim, boldly giving it to Ferraris. By means of diagrams a very clear proof was given of the fact that the field strength in a rotary motor is constant, and rotates at a constant rate; in this part of the paper also is to be found a very concise description (also helped by reference to diagrams) of the phenomena of rotary fields. Mr. Brearley touched but briefly on the use of condensers for producing the necessary lag, and dismissed it in a couple of lines, mentioning that the device is used by Leblanc and Stanley. Dolivo-Dobrowolsky's statement as to the 40 per cent. variation in field strength in Tesla's motor was disagreed with, but no reasons given for doing so. The "star" and "closed" winding of "tri-phasers" was discussed, and illustrations of various motors, &c., shown, and a much more constant field strength claimed for the "tri-phaser" over the "di-phaser;" the author stating that the variation in the Brown motor amounted only to 17 per cent.

In the final summing up, it is claimed that the advantages of three-phase motors are many, and the ease with which they may be worked gives the rotary field type a great advantage over the alternate current motor. The author said: There is no doubt that a motor which has no moving contacts of any sort, which can be connected directly to the mains has in this respect only, an advantage, but when we add to this the ability to start with considerable force and almost immediately attain its speed, it is obvious that these machines will prove a somewhat formidable rival to direct current motors, for, though as yet, we cannot say they are as efficient, yet they lend themselves to transmission of power purposes with much better results than direct current. It must not be thought, however, that the problem has been wholly solved, for there are still many points in which they might be improved. At any speed of the armature, other than that of the field, the armature windings are the seat of heavy alternating currents of low periodicity, which in their turn re-act on the field magnet, tending to choke off the current in the field magnets. It would appear then that there must be considerable waste of power at any speed but synchronism. The necessity of three wires is urged as an objection to this method. It is true, insulation has to be provided and paid for on a third wire, but the copper necessary to transmit a certain amount of energy is not greater than in the two-wire system.

In the present state of our knowledge we may be justified in drawing the following conclusions:—(*a*) That motors using "redressed" alternating currents are too liable to sparking, uncertainty of action, &c., to be of much value commercially, at any rate in large sizes. (*b*) That rotary field motors possess some advantages in point of convenience, simplicity, &c., over direct current motors.

The discussion on the paper has been adjourned till the end of the month, when a very interesting meeting is expected.

Electric lighting affairs are still very slack, and there is hardly enough work going to keep the various firms employed. The same cry comes from all quarters—nothing doing. Tenders closed on Monday last for the lighting of Katoomba, a fashionable summer resort in the Blue Mountains, possessed of a waterfall, which is available for power purposes. I believe two tenders only were received at first—the Brush Electric Engineering Company and Highland and Co.—but intimation was received by wire from Messrs. Woodhouse & Rawson, to the effect that their tender had been posted, and it was allowed to be included. Results are not yet to hand regarding either this tender or the Adelaide tender, the latter having been referred to Mr. Todd for report. The Redfern plant is now completed and has been running under trial for some little time with satisfactory results, but it has not yet been been taken over by the Municipal Council.

Sydney, *August 6th*, 1892.

The borough of Redfern has every reason to be proud of its new electric light station, which is, both internally and externally a very handsome and well fitted building. The engine-room, in which there is plenty of space to move about, contains two very fine horizontal compound condensing engines by Goodfellow & Co., of Manchester. These engines, which are identical in construction, are each 130 N.H.P., running at 87 revolutions with 90 lbs. steam pressure, the area of the high pressure cylinder being 132·7 square inches, and area of low-pressure cylinder 415·5 square inches, length of stroke, 2 feet. The counter-shafting is driven by means of ropes on a 10 feet driving wheel, and the alternators and exciters driven by belting from the counter-shaft. There are two 120 kilowatt Mather & Platt alternators, with 24 field-magnet poles, giving 120 ampères at 1,000 volts, with a frequency of 80 ∿ at 400 revolutions. Two 85 volt 10 ampère Manchester dynamos, running at 680 revolutions are used as exciters. The mechanical construction of these alternators appears to be well adapted for easy and rapid repairing, as any field magnet core or coil, or armature section can be easily removed without disturbing any other part of the machine.

In the boiler room there are two sets of multitubular boilers by Tinker Bros., of Hyde, near Manchester, each of 130 H.P. nominal; the feed-heater, pump, and injector, being by the same makers; there is a large tank under one end of the boiler room, capable of supplying sufficient water to keep both sets of boilers going for three or four days in case anything should go wrong with the city water mains. Adjoining the boiler room is a large room for coal storage purposes, with easy access to the street.

The alternators are at present supplying current to 406 25-volt 25 candle-power Thomson-Houston street lamps in 11 circuits of about 38 to 40 each, or 40 ampères in all. A No. 14 Callender wire is used for the outgoing lamp circuits, and a No. 10 for the return leads, of which there are three, each acting as return for four circuits. As the street lamps only utilise 40 kilowatts out of the available 120, it is intended to supply the remainder to private consumers, the charges to be as follows: 8 candle-power lamps, 10s. per annum; 16 candle-power lamps, 17s. 6d. per annum; 25-candle-power lamps, 27s. 6d. per annum; the light to be available from sunset to sunrise. Churches, halls, &c., to be charged by special contract, and hotels to pay 25 per cent. more than the ordinary prices. In view of the possibility of the private supply being taken up, four sets of mains have been laid in the principal streets, of 19/18 Callender cable. The wiring is all overhead, except in three or four places where Callender-Webber casing is used where a number of mains cross the streets. A stock of ten 50-light and twenty 25-light Mather & Platt transformers has been laid in as a provision for the proposed private consumption. It is proposed to keep the public and private lighting as far as possible separate, and with this object in view the switchboard has been made in two sections, one section entirely for the street lighting circuits, and the other for house lighting. There are the usual switches for changing circuits from one alternator to the other, &c.; the voltmeters and ampèremeters are of the Soames & Nalder pattern, made by Messrs.

Nalder, and two of Sir William Thomson's engine room voltmeters on the ampère balance principle. A Mather and Platt transformer is used for the 35 lamps used for lighting the station. There is a large room above the engine-room at present unoccupied, except by the lightning arresters and a few stores; the lightning arresters are in the form of brass cut into numerous points, passing through a hole in a block of brass, also cut into points and corrugations on the inside, the outer block being connected to earth.

It has been decided that the local town hall premises be provided with electric light fittings, the probable cost being put down at £100; as the number of lights required is 68, I don't fancy the council will get anything very elaborate, though no doubt some firm will be found to undertake the work even at that price. The construction work has been carried out by Mr. R. Oxlade, A.I.E.E., for the contractors, the Williamson Electrical and Engineering Company, under the supervision of Prof. R. Threlfall, consulting engineer for the Redfern Council. The Williamson Company have taken a further contract to run the plant for 12 months.

Sydney, *August* 15th.

DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.

IV.

THE fourth report of the Cantor lectures by Prof. Forbes deals almost wholly with two very interesting proposals by the Professor himself. The first one is to employ water raised to a height as a storage of power for electrical distribution; the second, to use town's refuse as fuel for electric power engines.

When one looks at what is being done in most large towns who have commenced their preparations for electrical distribution, and then listens to the warnings in these lectures, the conclusion must be that either the Professor is mistaken, or that the advisers in these towns don't know what they are about. Take Glasgow, for instance, and it is only one among many. There they have adopted low-pressure distribution with low-pressure feeders, chosen a site for their generating works right in the centre of a crowded, but very poor quarter of the city, a long way off from the best of customers, and coals and ashes must be carted long distances. The engines chosen may occupy the smallest possible floor space, but no regard is had to their economy either in steam consumption or in repairs. The class of consumers within reach of the supply use light only for one or two hours in winter, and not at all in summer, excepting a few public houses, who may have the light until 11 o'clock all the year round. The price fixed for supply renders its use for motors totally prohibitive. A gas engine would supply the power at one-sixth of the cost. Now, every one of these points is against the success of electrical distribution, and the danger is that on the completion and working of these municipal installations the results will not be satisfactory, and a reaction is bound to be produced, from which electrical engineering is certain to suffer.

The losses in the engines, the losses in dynamos, the losses in the feeders and mains, the losses in transformers and storage can be reduced more by skilful engineering at the initiation of an installation and a judicious choice of a site, and of engines and machinery, than by any improvements which can be made in these apparatus themselves. The men engaged in the manufacture and design of the machinery required for electrical distribution, attend thoroughly to every point in their economy and perfection; there is no fear for the electrical engineering business so far as it is entrusted to them. It is on the men who advise as to the choice of a system and fix upon its details, that the success or failure of a station for electrical distribution depends.

These Cantor Lectures are valuable in so far as they show up the weak spots in present and past practices in electrical distribution, and also for the valuable suggestions made towards bettering the practice in the future, as well as for the information conveyed regarding some things hitherto not studied much.

Considering that in all the towns in which electrical distribution has been taken up, there is already existing the machinery for collecting and burning towns' refuse; it is wonderful so few of them have attempted its use for generating steam for electric lighting. Prof. Forbes has given this subject much attention, and from actual facts ascertained by himself, has calculated that in most large towns sufficient fuel could be got from the refuse to do all the electric lighting in the town, allowing one lamp for everyone in the town. No doubt this is true, but the Professor, we are afraid, will meet with the common difficulty with which pioneer electrical engineers are familiar; he will find it much easier to light a town by electricity, produced from its own refuse, than it is to obtain an order to do it.

There can be no doubt that much could be saved in many towns by utilising the fuel portion of the refuse for electrical generating engines.

Prof. Forbes's other proposal is to form a reservoir for water at a great height, to pump water by steam engines continually up into this reservoir, then to utilise this high pressure water in driving turbines coupled to dynamos for supplying electric light and power.

The advantages to be gained by such a scheme are those arising from the storage of power in the raised water. A steam pump going constantly night and day at full load is perhaps the most economical arrangement in existence using the power of steam. Both engines and boilers are used under the conditions giving the highest efficiency. Triple expansion condensing engines, using an ejector condenser on each engine should, under these conditions, give one indicated horse-power easily for 1½ lbs. of coal.

As the engines and pumps would run continually, and the turbines and dynamos only for some hours daily, the horse-power of the engines would not require to be more than one-fourth or one-fifth of the horse-power of the turbines and dynamos, so that a large saving in first cost on engines and boilers would be effected, against which would be placed the cost of pumps, turbines and waterworks.

This scheme could be adopted in a few places only. Reservoirs cannot be formed anywhere, and in many places where they could be made the landed interests would prohibit them.

In some Scottish towns, such as Edinburgh, Inverness, Perth, and Aberdeen, reservoirs are possible; Edinburgh, as pointed out by the Professor, being, perhaps, naturally the best situated city in Britain for the adoption of this system. The reservoir is already existing at Dunsappie Loch, and could easily be increased.

If Edinburgh adopts such a scheme, together with the use of the fuel obtained from the town's refuse for driving the pumps, in all probability the installation would succeed; but such an installation being a sort of pioneer, would require engineering skill of a high order, and the aid of the highest qualified and talented electrical engineer that could be got. Both the hydraulic system, and the electrical distribution system chosen for the work, would require careful consideration by unbiassed and disinterested engineers, as upon these, as much as upon the inherent economy of the scheme, would depend its success.

Prof. Forbes describes a somewhat similar scheme, which has already been put into practice at Lucerne and Geneva; but at these places the whole power is water power. The power is first obtained from a large fall at a low head, this pumps up water to a high level; the water from the high level is used for distribution of power and light. In fact, the system is a hydraulic transformer system, with storage; the low-pressure large volume waterfall is converted into a high-pressure small volume waterfall by turbines and pumps, and the power is stored in a reservoir at high pressure.

The advantages of the storage are great, but the advantages of distributing the water at high pressure are also great, hence the success of the scheme at these places. In the case of using steam as the original power we obtain only the advantages due to the effective storage by water; but these are very great advantages.

The frequency of the alternating current to be used in the future is again commented on, and confidently expected to be reduced to from 6 to 10 per second.

Low frequency, as we have already pointed out, can be of advantage only for driving motors in which the field magnets and armatures are excited both by alternating current; it is not to be tolerated for lighting purposes.

It has no advantages for the conversion of the alternating current into a continuous current.

Low frequency has already been adopted by the multiphase current pioneers; there, of course, it has every advantage. Multiphase motors are excited by the alternating current, hence require low frequency to keep down the value of the impedance of the magnet coils. Multiphase currents are also converted into continuous current by motor generators; they also require low frequency.

All this discussion regarding motors, low frequency, and multiphase currents and their advantages, is not in any way comforting to the companies and corporations already possessing supply plants.

These plants are high frequency where alternating. What is wanted by them is a motor to work with the only frequency they can supply, and an apparatus by which they could economically and safely convert their high frequency alternating current into a continuous current; the first want is not likely to be filled just yet, but we think the second may be filled before long.

With regard to continuous current and central station work at low pressure, this ancient system very likely will be obsolete by the time the professor delivers his next lectures on Distribution. Before long, these must be tacked on to high-pressure feeders and become simply sub-stations. By getting rid of the absurd engines and boilers now used by them, and drawing their supply from a large generating high-pressure centre, the cost of electricity will be reduced very considerably.

In London, some of the low-pressure central stations could discard their engines and boilers and obtain a supply at high pressure from Deptford, for instance, at a lower cost than now obtains. Possibly, if the alternating current could be converted into continuous current, this plan would be adopted in some cases.

We entirely agree with the Professor in regard to accumulators; they have an enormous convenience, and only their low efficiency and high price limits their universal use in electrical distribution.

A NULL METHOD OF ELECTROMETRY.

By T. H. MURAS.

THE null method of comparing differences of potential by means of a sensitive electroscope, appears to be scarcely so well known as it deserves to be. It permits fairly accurate measurements of the electromotive forces of small experimental voltaic cells, &c., to be made with an instrument such that no definite measures could otherwise be obtained from it. With a simple quadrant electrometer, made by Messrs. Elliott, when the needle is charged so that one volt difference of potential of the quadrants gives a deflection of about 100 mm. on a scale 1,000 mm. distant, the deflection is not sufficiently constant or definite to permit direct comparisons of potentials. Moreover, the zero of the needle is not stationary. But by using the null method, perfectly definite results are obtained, the accuracy of which is, however, limited by the want of sensitiveness of the electrometer, errors of 1 per cent. being possible in measuring the E.M.F. of a cell.

A suitable arrangement of connections to a quadrant electrometer is illustrated in the diagram. The casing, C, of the instrument is connected to the earth, E, and the needle is charged to the maximum consistent with its retaining its proper position. The two pairs of quadrants are normally connected by a spring key, K. One pair is connected permanently through variable large resistances, R, T, with the earth, and with a battery, S, such as one or two storage cells, the E.M.F. of which is larger than that of the cell to be compared, and may be relied on to remain constant during the observations. These arrangements serve to charge one pair of quadrants variably. The key, K, when depressed, connects the other pair with the standard cell, X, the other pole of which is earthed. In making a measurement, the resistances, R, T, are varied, until no movement of the electrometer needle occurs when the key is depressed. The standard cell, X, is then replaced by a cell, Y, to be compared with it, and the process repeated. If R, T, r, t, are the resistances in the two cases, the resistance of the battery, S, being negligible, and if X, Y, S, are the E.M.Fs., then

$$S = \frac{R + T}{R} \cdot X$$

and

$$Y = \frac{r}{r + t} \cdot S$$

or

$$Y = \frac{r\,(R + T)}{R\,(r + t)} \cdot X$$

If R + T is constant, $Y = \frac{r}{R} \cdot X$.

For some purposes it is sufficient to place the standard cell at X, and the cell to be compared with it at S, the comparison being direct. The resistances, R, T, may be those in an

ordinary post-office box, or preferably such that the total resistance, R + T, may be kept constant, in which case two Leclanché cells may be used at S. It will be seen that in no case can the current from the cell, X, be more than is necessary to alter the charge of the key and one pair of quadrants, so that polarisation is reduced to a minimum, and the results are independent of the size or resistance of the cell.

UPSETTING THE THEORY OF THE CONSERVATION OF ENERGY.

HAD "Mr. Jefferson Brick" been acquainted with Colonel Leonard Heakle, he would doubtless have introduced him to "Martin Chuzzlewit" with his customary formula as "One of the most remarkable men in our country, sir!" and he would have been justified in his description. The gallant colonel is going to circumvent nature with "the most stupendous undertaking ever planned by the mind of man." He does not himself expect that his project will seem credible to the general public at first, and we think our readers will endorse this opinion when they try to understand the appalling scheme with which he proposes to revolutionise electrical industry and upset all the deductions of Carnot, Joule, Colding, Helmholtz, and other "misguided" scientists.

The colonel shall speak for himself. According to *Electricity* he says:—

"It is well known to experts in chemistry that all substances are material, and subjects of natural laws, and also that all material things are formed of atoms which are arranged by polar action and held together by magnetic cohesion; and that between these myriads of atoms there are myriads of inter-atomic spaces filled with ether; and it is equally well known to men acquainted with electrical science that ether is the element, or substance, through which electricity passes, whether metals or some other medium be used to conduct it. Silver has a full conductive capacity of 100, while copper has a capacity of only 73-100. Why this resistance of 27-100 which diverts the electric current from light and power purposes into the development of heat? My answer is, I have found by disintegrating various metals, by

both chemical processes and mechanical displacement of their molecular formation, that the atoms are found to be arranged across the inter-atomic spaces exactly proportioned to the resistance found in the metal, thus arresting the electric current to precisely that extent. The remedy is found in a metal whose atoms lie longitudinally with the inter-atomic spaces. Experiments and observations involved in making the foregoing discovery have revealed a knowledge of the means by which more than 8,000,000 lbs. of energy can be stored in a battery of one cubic foot of metal."

Many of our readers will doubtless consider that the statements and admissions in this paragraph put Colonel Heakle immediately out of court, to say nothing of his error in using the unit of mass. This "remarkable man" claims to have discovered the secret of transmitting power without loss of energy! He has on foot a scheme for constructing a gigantic power house across the brink of Niagara Falls, and states that he will transmit "electric force to Louisiana without appreciable loss."

In our simplicity, we have always understood that owing to experimental results in all branches of physics, we were entitled to consider as proved the theory enunciated long ago by Lord Kelvin of the dissipation of energy in nature. This principle of dissipation, or degradation, as Prof. Tait prefers to call it, we interpret as follows:—When energy is transferred from one body to another, the operation always involves a transformation of energy, and every transformation involves a certain amount of degradation; that is to say, some portion of the new form is lower in the scale of energy than the original form, because of friction, imperfect elasticity, and so on. In short, every operation in nature involves the assumption of a relatively useless or non-available condition by a portion of the energy employed.

Colonel Leonard Heakle can say, *Nous avons changé tout cela.*

A corollary of this achievement will be the revision of the theory of the conservation of energy. Having accomplished this, the Colonel may then turn his attention to the *perpetuum mobile*, and be certain of success.

We understand that the plans for the Niagara power-house are to be exhibited at the World's Fair, but would suggest that the Colonel himself should be exhibited, and that he should be allotted ample space.

NEW PATENTS—1892.

16,284. "Improvements in electric call bell indicators." W. JENNINGS, jun. Dated September 12th.

16,292. "Soldering aluminium." O. NICOLAI and C. LANGENBACH. Dated September 12th.

16,300. "Improved method of and means for supplying electricity to the carbon electrodes employed in the electrolysis of fused electrolytes. H. H. FREI. Dated September 12th.

16,301. "Improvements in electrical fire and burglar alarm connections." H. T. WILSON and N. SCHWAB. Dated September 12th. (*Complete.*)

16,315. "Improvements relating to electric telegraphs." F. E. W. BOWEN. Dated September 12th.

16,328. "A new principle of conveying to or from the earth electricity to human beings." E. SPRATT. Dated September 12th.

16,335. "Improvements in electric telephones." E. M. HARRISON. Dated September 13th. (*Complete*).

16,371. "Improvements in electric locomotives." W. H. SOLEY, W. W. PERKINS, J. WOLSTENCROFT, W. O'NEILL and W. H YELLAND. Dated September 13th. (*Complete.*)

16,427. "Improvements in magneto generators, battery switch bells, and the like." G. A. NUSSBAUM. Dated September 14th.

16,434. "Improvements in the construction of electric light switches, cut-outs, ceiling plates, wall-connectors, lamp-holders, and the like." C. M. DORMAN and R. A SMITH. Dated September 14th. (*Complete.*)

16,456. "Improvements in or relating to ammeters and voltmeters." E. F. MOY and F. TEAGUE. Dated September 14th.

16,461. "Improvements in secondary batteries." W. MAIN. Dated September 14th. (Date applied for under Patents Act, 1883, Sec. 103, 15th February 1892, being date of application in United States.) (*Complete.*)

16,469. "Improved contact fittings for movable electric lamps." C. E. WEBBER. Dated September 14th. (*Complete.*)

16,489. "An arrangement for working an electrical rock drill or similar apparatus." A. L. TAYLOR. Dated September 15th.

16,545. "Improvements in and relating to dry and other galvanic batteries." A. E. J. BALL. Dated September 16th.

16,550. "Improvements in electric telegraphs." J. F. HOFFGAARD. (Communicated by H. P. Fiyd, Denmark). Dated September 16th.

16,561. "Improvements in dynamo-electric machines and motors." A. W. MESTON. Dated September 16th. (*Complete.*)

16,570. "An improved method and apparatus for electrical propulsion of vehicles." F. E. ELMORE. Dated September 16th.

16,571. "Improvements in the connections of electric motors with the sources of electricity from which they are supplied." WOODHOUSE and RAWSON UNITED, LIMITED, and W. S. RAWSON. Dated September 16th.

16,588. "Production of oxygen and hydrogen by electrolysis of water." P. GARUTI. Dated September 16th. (Date applied for under Patents Act, 1883, Sec. 103, April 25th, being date of application in Italy.)

16,613. "Improvements in fire-alarm telegraphs." J. H. GREENWOOD. Dated September 17th.

16,614. "Improvements in and relating to advertising by means of electric light." R. R. L. ROSOMAN. Dated September 17th.

16,615. "Improvements in connection with electric incandescent lamps and holders therefor." T. FROGGATT. Dated September 17th.

16,624. "Improvements in automatic electric winding mechanism for electricity meters operated by the aid of clockwork mechanism, and for clocks." G. W. FAIRALL. Dated September 17th.

16,629. "Improvements in the manufacture of aluminium and apparatus therefor." W. MILLS. Dated September 17th.

16,644. "Improvements in instruments for measuring electrical currents." SIEMENS BROTHERS & Co., LIMITED. (Communicated by Siemens & Halske, Germany.) Dated September 17th.

16,656. "Improvements in or appertaining to electric light fittings." F. W. PLUMSTEAD. Dated September 17th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

18,522. "Improved method of and apparatus for welding or working metals electrically." W. P. THOMPSON. (A communication by C. L. Coffin, of America.) Dated October 27th. Claims:—1. The described method of electrically heating metal for working or welding, consisting in connecting the material to be heated with one pole of a generator, placing it in contact with a conductor in proximity to the point of contact between such and a second conductor which is connected with the other pole of a generator, and passing a heating current through said material and said conductors, whereby said material is heated directly by the action of the current, and also by the heat developed at the point of contact between the two conductors. 2. The described method of welding metal electrically, consisting in connecting the material to be welded with one pole of a generator, placing it in contact with a conductor in proximity to the point of contact between said conductor and a second conductor which is connected with the other pole of a generator, and passing a heating current through said material and said conductors, whereby said material is heated directly by the action of the current, and also by the heat developed at the point of contact between the two conductors, and completing the weld by pressure. 3. The described apparatus for electrically heating metal for working or welding, combined and arranged substantially as set forth.

19,458. "Improvements in electric accumulators or storage batteries." W. P. THOMPSON. (A communication by N. H. Edgerton, of America.) Dated November 10th. Relates to the construction and arrangements of the electrodes, and their insulating containing cells or pockets, within the main cell of the battery, in such manner as to develop an increased voltage or tension of electrical energy. 4 claims.

19,469. "Improved device for bringing the receiving instruments of telephones against the ears of the person speaking, and returning the same to their position of rest, as also for circuiting the telephone in and out." R. GROVE and C. LEHR. Dated November 10th. Consists mainly of hinged brackets, arranged in appropriate manner on each side of the apparatus, and carrying the receiving instruments. Underneath the apparatus a desk is arranged, on or under which a button is mounted, the said button being connected with the brackets above mentioned by suitable mechanism, so that on operating the button, the receiving instruments will be brought into proper position against the ears, and simultaneously the apparatus circuited in On releasing the button, the receiving instruments are returned to their original position, and the telephone is circuited out. 3 claims.

19,901. "Improvements in or relating to welding or working metals electrically." W. P. THOMPSON. (A communication by C. L. Coffin, of America.) Dated November 17th. Consists in the process of welding metals electrically, by first separately subjecting the articles to be welded to the action of a heating current and the voltaic arc, and then pressing the heated articles together to form the weld. 2 claims.

20,604. "Improvements in electric motors or generators." H. H. LAKE. (Communicated from abroad by W. Stanley, jun., and J. F. Kelly, of America.) Dated November 26th. Consists in the combination in the machine, with the rotating armature and coil or coils thereon, of a stationary coil or coils adapted to produce an effect equal, but opposite to, that of the coil carried by the armature

whereby the self-induction, and consequent retardation in the armature, will be neutralised or overcome. 4 claims.

20,629. "Improvements in holders for incandescent electric lamps." C. M. DORMAN and R. A. SMITH. Dated November 27th. Consists in arranging the necessary parts, so that in a holder of moderate size, the insulated wires can be brought right through separate holes in the insulated base of the lamp-holder, and safely and easily coupled up on the front. 5 claims.

20,840. "Improvements in armatures of dynamo electric machines." J. NEBEL. Dated November 30th. Relates to certain general principles, according to which armatures can be made with multiple conductors, having their connections to each other and to the segments of the commutator so arranged, that even when large currents are generated, there is little or no sparking at the commutator, and very little heating of the armature. 4 claims.

20,913. "Improvements in electrically propelled vehicles." M. W. DEWEY. Dated December 1st. Consists chiefly in the combination with a wheeled vehicle having two axles, and one of said axles adapted to turn on a vertical axis to steer or guide the vehicle, of a circular rack connected to the axle, an electric motor mounted upon the vehicle, two loose pinions on a shaft geared to said rack, and driven in opposite directions by the motor, a clutch between the pinions to clutch either pinion and to turn the shaft, and means to operate the clutch. 16 claims.

20,924. "Improvements in and relating to electric fire engines and the like." M. W. DEWEY. Dated December 1st. The object of the invention is to electrically propel an electric fire engine to and from a fire. 18 claims.

20,930. "Improvements in electrically-propelled vehicles." M. W. DEWEY. Dated December 1st. The objects of the invention are to dispense with a compensating gear for the purpose of allowing a relative movement of the wheels on opposite sides of a vehicle, and to propel a vehicle by an electric motor mounted upon an axle thereof, and having parts adapted to rotate in opposite directions. 9 claims.

21,442. "Improvements in secondary or storage batteries." H. H. LAKE. (Communicated from abroad by I. L. Roberts, of New York.) Dated December 8th. Consists of any convenient form of cell or jar, in which is used a plate or mass of metallic iron as electrodes, and a conductor or plate of a material electro-negative to iron, preferably carbon, similar to the ordinary negative carbon element of a galvanic battery. For the excitant or solution is used a solution of chloride of iron. 3 claims.

21,449. "Improvements in switches for electrical purposes." F. G. HOWARD. Dated December 8th. Claims:—1. The use of a slotted handle part working on a pin or staple which is rigidly fixed to the contact bar of a tumbler switch for electrical purposes, substantially as described and with reference to the drawings. 2. The construction of a switch for electrical purposes, substantially as described.

21,565. "An improved microphone." G. F. REDFERN. (A communication by W. Deckert, of Vienna.) Dated December 9th. Claims:—1. In a microphone the use of an electrode, having its surface formed with pyramidal projections, alternating in the manner described, for the purpose of preventing the carbon grains from falling. 2. In a microphone the use of a vibrating diaphragm, made of conducting material such as carbon, and provided on one side, except on the central part, with a thin layer of insulating elastic fibre, such as wool, cotton, silk and the like, substantially as described. 3. The improved microphone, described and illustrated in the drawing.

CORRESPONDENCE.

Magnetism and "Magnetism."

It is certainly well to preach with every sort of emphasis and insistence, the accurate use of terms, and a contributor to the ELECTRICAL REVIEW is within his right in pointing out what may no doubt be a valid distinction between the *magnetism* of the earth currents which affect inanimate matter and the "*magnetism*" which is a more or less appropriate term for some phenomena studied by psychologists. But he forgets, perhaps, that there is another factor than bare terminology which affects the intelligibility of a statement and that is its context, and I do not think that, even when the quotation marks are omitted from the term "magnetism" in Mrs. Besant's articles in the *English Mechanic*, any one need be in doubt as to which magnetism she means.

At any rate, when one makes profession of being an amateur of accurate statement it would seem to be part of the prudent, pre-cautious man to "take heed to his own ways that he sin not with his tongue," and he should "keep his mouth with a bridle."

Your contributor approves, and very justly, Mrs. Besant's *dictum* that "Nature does not alter her facts to suit academics, scientific or otherwise." That is a correct statement of undoubted fact. But he then proceeds to add "neither does she permit . . . any abnormal specimen of the genus *homo* to distort her facts to suit their own purposes." A statement which is flatly contradicted by daily experience. The thing is done every hour, and "Nature" looks on with supreme equanimity.

We may flatter ourselves that we can form a good guess at what your contributor wished to say but his statement as it stands is sadly lacking in that scientific accuracy he so ardently admires.

J. C. S., *F.T.S.*

The E.M.F. necessary for Arc Lamps.

In your own columns and in those of your contemporaries, allusion is often made to the E.M.F. required to run arc lamps, and it would appear that there is some difference of opinion upon the subject. Some makers recommend an E.M.F. of 60 volts for their lamps, while others state that 55 volts, or even 50 volts are sufficient, and it seems to be generally conceded that it is impossible to obtain a silent arc with less than 45 volts as a back E.M.F. or equivalent to a back E.M.F. of 39 volts is always present. Beyond this fact, however, it must be noted that if a lamp is to be run alone, it is necessary to use a certain amount of resistance in series, although this is unnecessary where several are run in series.

It is interesting, therefore, to observe that the practice in Germany appears to differ considerably from that in use over here. For example, the town of Cologne is supplied by alternating current, and the available potential is either 72 or 36 volts, according as the transformer is wound for one or other. The potential of 36 volts has been chosen, because this is the lowest voltage upon which an arc lamp, run by itself, will burn properly. The alternators are by the Helios Company, and the frequency is, 102 per second. The transformers, as a matter of fact, are wound to transform down from 2,000 volts to 72 volts, but a middle terminal is provided, so that a potential of 36 volts only may be had if required. I am informed that four of these arc lamps have been successfully lighted in series upon mains having a difference of potential of only 112 volts. I shall be extremely pleased to hear the views of any of your readers upon this question, as it would appear that the German types of arc lamps can be used with considerably less potential than those in common use in this country.

It seems, also, that as all the glow lamps must be made for 72 volts, that the section of the house mains must be larger than is usual with 100 volts, the ordinary pressure in this country.

E. R. Dolby.

[Mr. Dolby does not seem to have taken into consideration the different conditions in the arc which *alternating* currents set up.—EDS. ELEC. REV.]

"Current that Cures."

I note with much pleasure that you recommend a suggestion from Mr. Newman Lawrence, made at the conclusion of his admirable article on the "Current that Cures," that a school of training for medical electricians should be established.

Perhaps a word from this Society of Practical Operators will strengthen your recommendation. The society was formed about a year ago with the distinct object of raising the status of operators both in medical electricity and in massage. The want of a recognised institution in which satisfactory instruction in all that pertains to the art could be obtained, is one that has been much felt. This is specially true of the electrical part of the work, and such training as you indicate would be gladly availed of.

In order efficiently to carry out instructions of medical men, it is necessary to be in possession of qualifications procurable only through an independent school of training worthy of the confidence of all concerned; and it is sincerely to be hoped that in the interests of medical men, operators, and, most of all, patients, that your voice may awaken the public mind to the need of such an institution.

William Elligott,
Hon Sec.